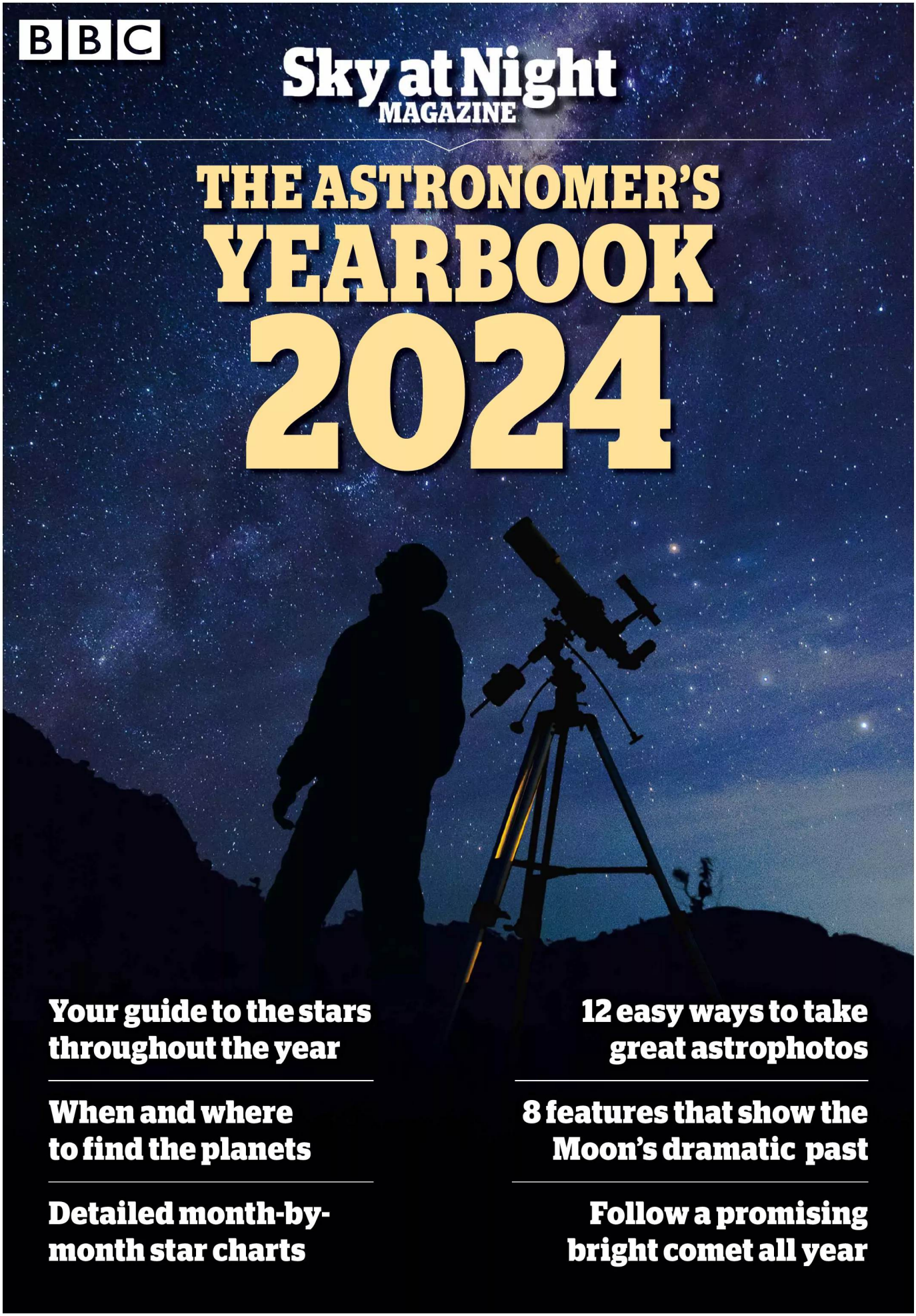
BBC

Sky at Night MAGAZINE

THE ASTRONOMER'S YEARBOOK 2024



Your guide to the stars throughout the year

When and where to find the planets

Detailed month-by-month star charts

12 easy ways to take great astrophotos

8 features that show the Moon's dramatic past

Follow a promising bright comet all year

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Welcome

This comprehensive stargazing guide provides all the information you need to enjoy the best sights in the night sky throughout 2024.

The Sky Guide offers useful advice, month by month, to help you navigate through the cosmos. Discover the delights of constellations such as Cancer, Aquarius, Ophiuchus and Coma Berenices. Find out the best times to see meteor showers or the moons of Jupiter and Saturn transiting across their parent planets, and don't miss the chance to catch planetary oppositions, occultations and rare conjunctions.

There are also a range of longer articles that let you delve a bit deeper: journey through the lunar landscape in eight fascinating features, take a tour of Orion, get to grips with standout springtime galaxies, and ensure you don't fall prey to classic astrophotography pitfalls.

If you're up for a challenge in 2024, have a go at tracking a comet, spotting intriguing banded craters on the lunar surface or observing open clusters in the Challenge Yourself section. You'll also find loads of practical advice, such as the best equipment available, and how to make a simple dew heater for your camera lens. And don't miss the gallery of winning images from *Sky at Night Magazine*'s monthly photo competition.

All this and more! Indeed, with the *Astronomer's Yearbook* to hand, you can make the most of your nights under the stars in 2024. Enjoy, and clear skies!

Chris Bramley, Editor

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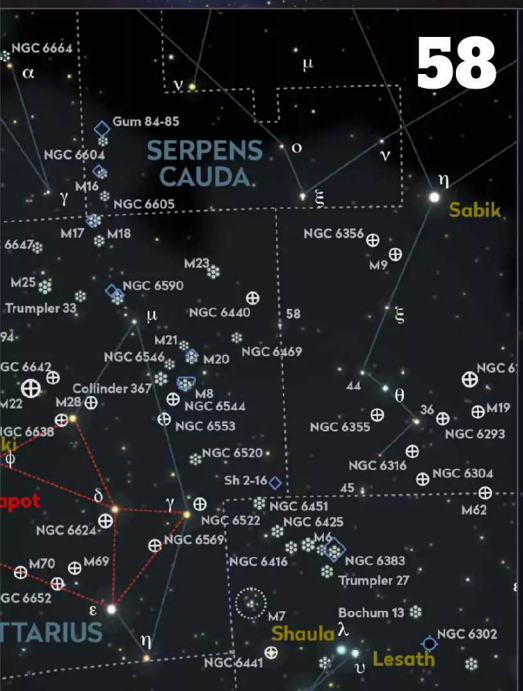

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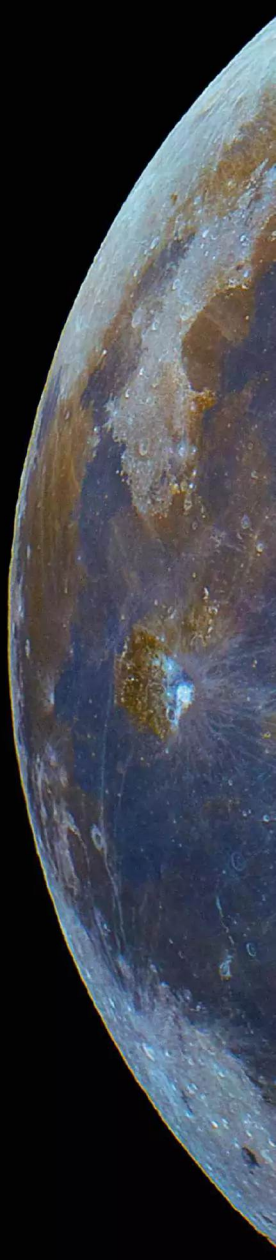
A history of the Moon in eight features



The Moon bears the scars of its long and violent past. Astronomer **Will Gater** looks at eight features that reflect its extraordinary history which you can see for yourself

WILL GATER

Few objects in the Solar System record the remarkable history of our planetary neighbourhood more starkly than the Moon. Not only does it bear the scars of eons of impacts by asteroids and comets, but its very existence is testament to a cataclysmic collision that's thought to have forged the Earth we stand on today. When we gaze at the airless lunar surface, a barren landscape of deep shadows, shining mountain peaks and grey basalt plains, we can also reflect on our own small imprint, quite literally, on the cosmos. The footprints of humanity's first Solar System explorers remain there even to this day, and likely will do so for millennia. In this feature, we highlight eight areas for you to examine with a telescope that tell the story of the past, present and future of our nearest neighbour. Let's start by rolling back the clock to the Moon's early days. ▶

1. The seas of the lunar nearside

Eons of heavy bombardment formed the Moon's basins

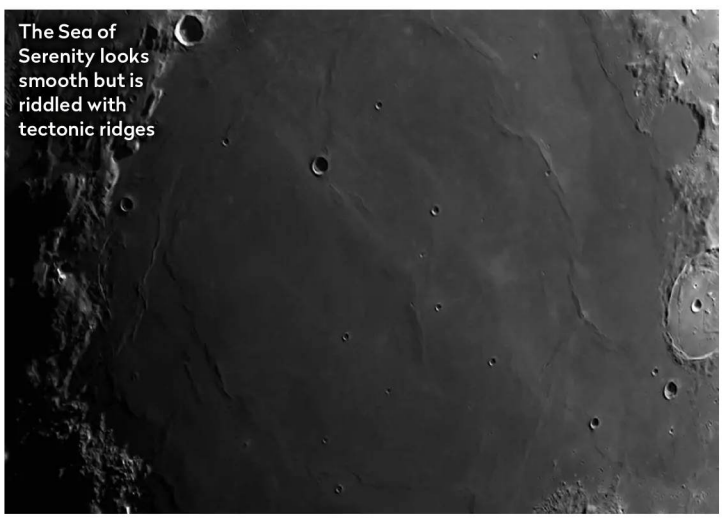
About 4.5 billion years ago, the Moon was formed in a violent impact when an object about the size of Mars smashed into the early Earth. This cataclysm left a cloud of superheated material circling Earth that eventually coalesced into the Moon – or that's our current understanding. After around 500 million years, our companion in space had cooled to form a solid body, rather than a seething ball of molten rock. But it was around this time that another series of massive impacts are thought to have occurred. These punched into the lunar globe, leaving enormous scars across its surface, known as basins.

Over time these are believed to have been filled in by immense flows of molten rock from within the Moon, becoming the lunar 'seas' we observe on the Moon today. Known to astronomers as 'maria', these dark regions create the 'face' in the Moon and are visible to even the naked eye. They are made of dark, basaltic rock and extend in vast, vaguely circular plains across much of the lunar nearside. One of the most interesting to observe with a small telescope is the Mare Nectaris, in the southeast quadrant of the Moon's disc. Thought to be just under four billion years old, when the lighting conditions are right – as they are around 3–4 and 18–19 days after new Moon – you can still see hints of concentric ring shapes thought to be left over from its formation.

Mare Nectaris, an easy spot with its bright stripe, is an impact basin that flooded with lava

2. Mare Serenitatis wrinkle ridges

A shrinking skin lined the Moon's face with wrinkles



The Sea of Serenity looks smooth but is riddled with tectonic ridges

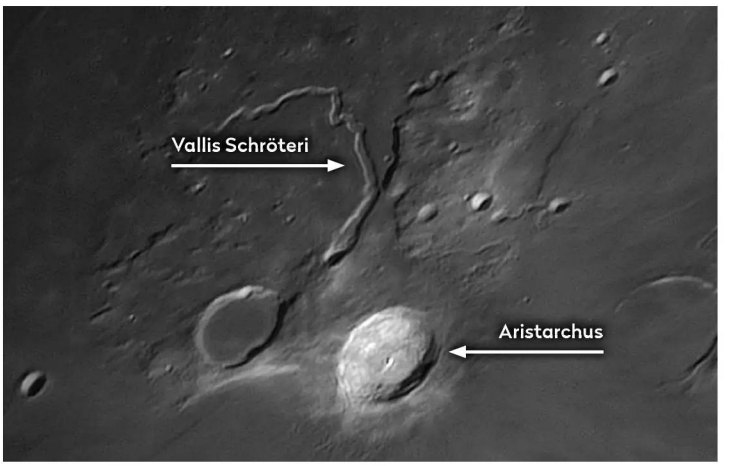
WILL GATER X 4, PETE LAWRENCE

As you cast your eye over some of the lunar seas at the telescope eyepiece, you may notice that these ostensibly smooth basalt plains actually show subtle textures. Not only are there clear variations in their colour – or rather shade of grey – but they also contain features where the land rises and falls in distinct narrow ridges, winding across the surface. These are known as 'wrinkle ridges' and for a while there was a debate about how exactly they formed. Were they volcanic in origin or a product of the seas deforming as these landscapes contracted after their formation? Scientists now think that in most cases it was likely the latter: the ridges emerged when the lunar seas experienced underground movements that wrinkled up the expansive basalt plains above. Recent research suggests the ridges formed around 3.4 billion years ago.

With a small telescope of around 4–6 inches in aperture, the best time to look for wrinkle ridges is when they are illuminated obliquely, that is when they are positioned near to the terminator. Pretty much the entirety of the Mare Serenitatis is criss-crossed by wrinkle ridges, and are well-lit 4–5 and 19–20 days after new Moon. There are also some other wonderful examples in the northern Mare Imbrium, close to the Bay of Rainbows, so you may want to note when the terminator passes through the region.

3. Vallis Schröteri

An immense eruption made the longest valley on the Moon's near side



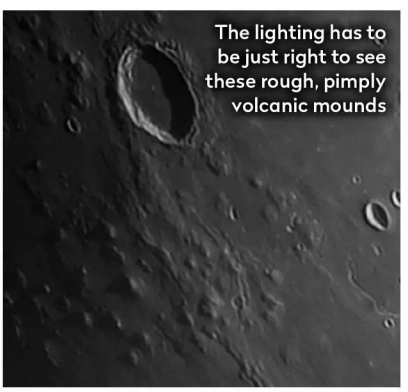
▲ **The snake-like 160km valley sits close to prominent crater Aristarchus, terminating in a wide feature called the Cobra's Head**

Lunar volcanism has sculpted and shaped many of the surface features we see through a telescope today. The next two stop-offs in our history of the Moon demonstrate this perfectly.

Within the great expanse of the lunar sea known as Oceanus Procellarum, on the western side of the Moon, lies the striking crater Aristarchus. You can't miss it. Even with binoculars, its bright walls stand out prominently from the darker plains surrounding it. Yet, look at it with a telescope and you'll notice there's an even more intriguing feature than Aristarchus lying close by. Extending away from the crater to the northwest is a wiggling line, known as the Vallis Schröteri or Schröter's Valley. This is what lunar geologists refer to as a 'sinuous rille' and it is thought to have been formed about 2.5 billion years ago when an immense eruption of lava carved a long, valley-like path through the landscape. In total Vallis Schröteri wanders over 160km across the lunar surface and is around 500 metres deep. Its large extent means that the valley is pretty easy to see in a small scope – though as we've seen with other features, the right illumination is key. To really see it well, aim to observe it 12–13 or 27–28 days after new Moon, when the lighting conditions are ideal.

4. The Marius Hills

A landscape littered with enigmatic volcanic lunar domes


The lighting has to be just right to see these rough, pimply volcanic mounds

Heading south across the Oceanus Procellarum we reach another volcanic landscape thought to have emerged two to three billion years ago, but which may be as young as 800 million years in places. The surface here, west of the bright crater Kepler, is dominated by huge areas of flat lunar sea and a scattering of moderately-sized craters. Yet when the terminator sits close to the crater Marius, it is possible to see that there are numerous small peaks in this region rising up from the smooth basalt surroundings of Procellarum.

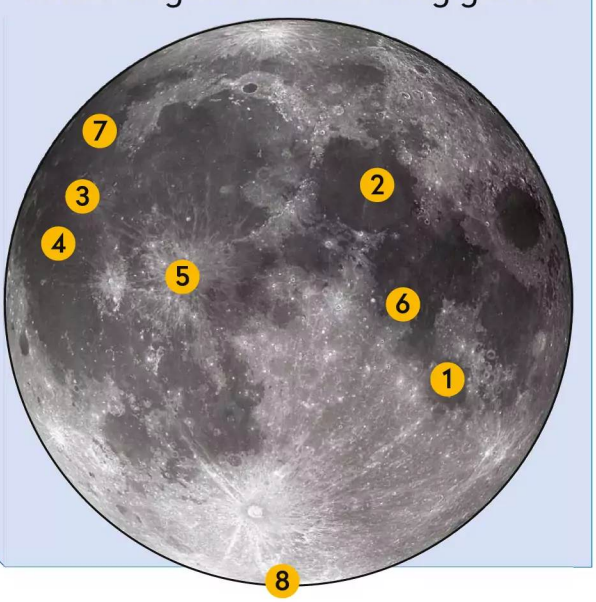
These raised 'bumps' are known as the Marius Hills. Referred to as lunar domes, they are similar to shield volcanoes on Earth, which form when lava oozes onto the surface creating rounded volcanic peaks. Magma coming up from deep below the surface may then have caused further eruptions that formed the valley-like rilles in this area. These can also be photographed with modest imaging equipment on large telescopes. To see the Marius Hills well visually, though, you'll need a telescope of 150–200mm and a night of good seeing. ▶

What kit to use

Naked eye | Binoculars | Small telescope | Large telescope

Where to find our eight lunar features

An at-a-glance observing guide

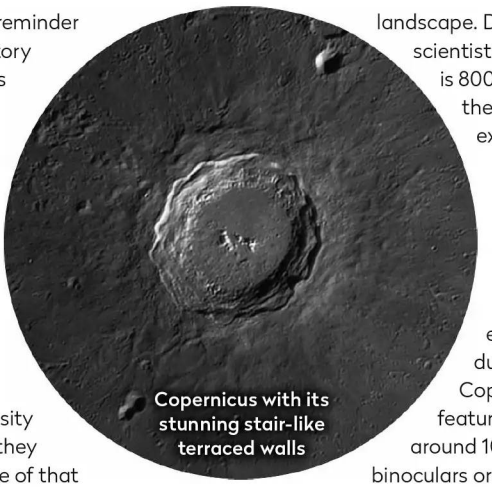


5. Copernicus crater

Apollo 12 and 14 explored south of the crater and returned samples of ejecta from its formation

There is perhaps no better reminder of the Moon's dramatic history than the myriad of craters that pepper its globe – from the centimetre-sized ones visible in Apollo surface images, all the way up to those large enough to see from Earth with the naked eye. The rate of asteroid and comet impacts has dropped off over time but, even today, small meteoroids still slam into the surface.

The craters of the Moon have been central to piecing together its history. When linked to the samples returned home by the US Apollo missions, the density of craters on any given surface and how they overlap can be used as proxies for the age of that landscape. Detective work like this leads planetary scientists to believe that the crater Copernicus is 800 million years old. Its formation marks the start of the 'Copernican' era that extends to the present.



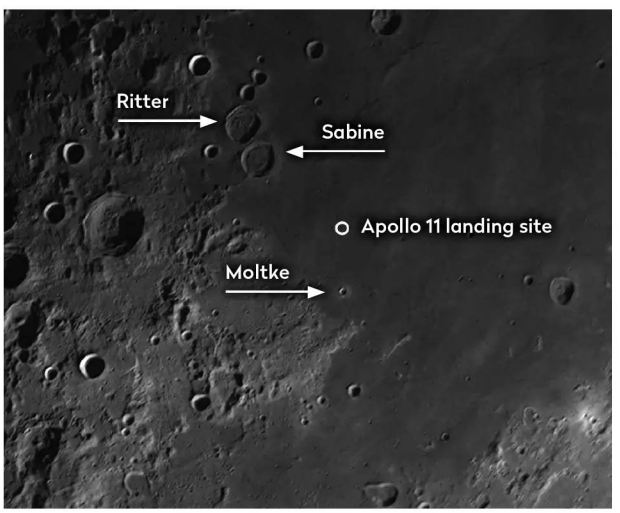
Copernicus with its stunning stair-like terraced walls

Copernicus is one of the Moon's most visually stunning craters. As well as having rippling terraced walls that change appearance over the lunar day, it is surrounded by an impressive ray system. These were made when ejecta was thrown over 600km away during the violent impact that created Copernicus. To see this extraordinary feature for yourself, seek it out on the nights around 10 and 25 days after new Moon, using binoculars or a small telescope.

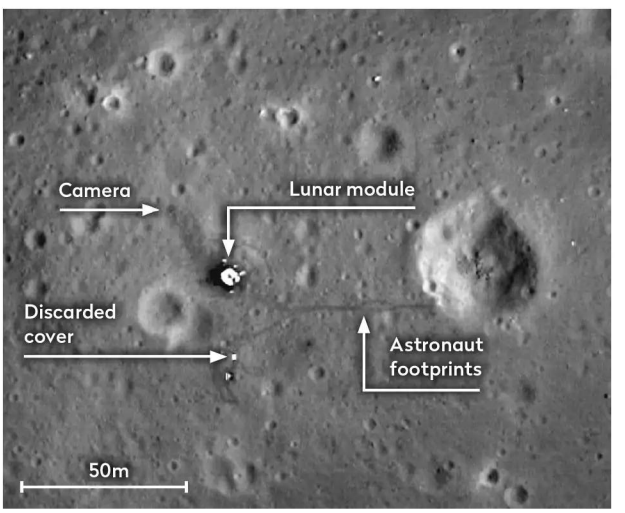
6. The Apollo 11 landing site

A small moment in the Moon's lifetime, but a giant leap for mankind

Our next stop brings us to where the timeline of our own species and that of our nearest neighbour intersect. More than 50 years ago, humanity made its first steps onto another world during the Apollo 11 mission. The landing site where US astronauts Neil Armstrong and Edwin 'Buzz' Aldrin completed that historic exploration lies in the southern half of the Mare Tranquillitatis, the Sea of Tranquility. While it is not possible to see any of the mission hardware that the crew left there with a telescope from Earth, NASA's Lunar Reconnaissance Orbiter in orbit around the Moon has been able to photograph the lunar module descent stage and trails left by the astronauts. It can still be fun to track down the landing area at the eyepiece, though. Seventeen to eighteen days after new Moon are good times to go looking for it. First locate the pair of craters Ritter and Sabine on the edge of the Mare Tranquillitatis. Then track your eye towards the promontory that pokes out into the sea close to the crater Moltke. About half way along this line is the area where Apollo 11 landed.



▲ In the southern Sea of Tranquility, track down from crater duo Ritter and Sabine towards Moltke to find Apollo 11's landing site



▲ A Lunar Reconnaissance Orbiter photo taken from just 24km up shows the tracks from Aldrin and Armstrong's 2.5-hour moonwalk

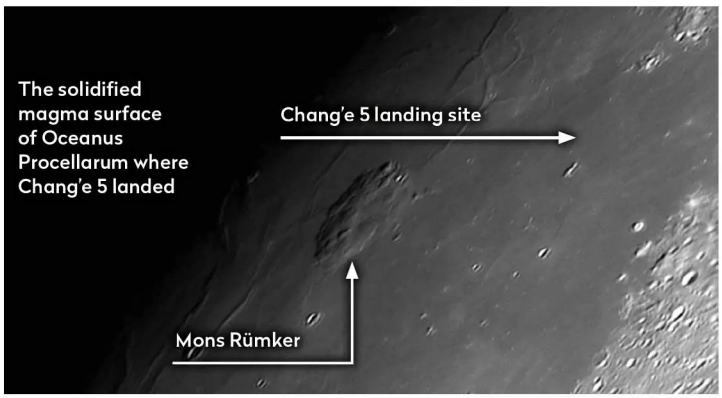
WILL GATER X 4, NASA GODDARD/ARIZONA STATE UNIVERSITY, CNSA/CLEP

7. Chang'e 5 landing region

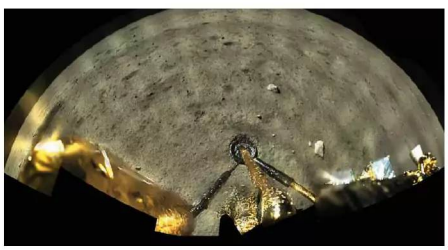
The vast Ocean of Storms, where the Chinese led the vanguard of modern missions

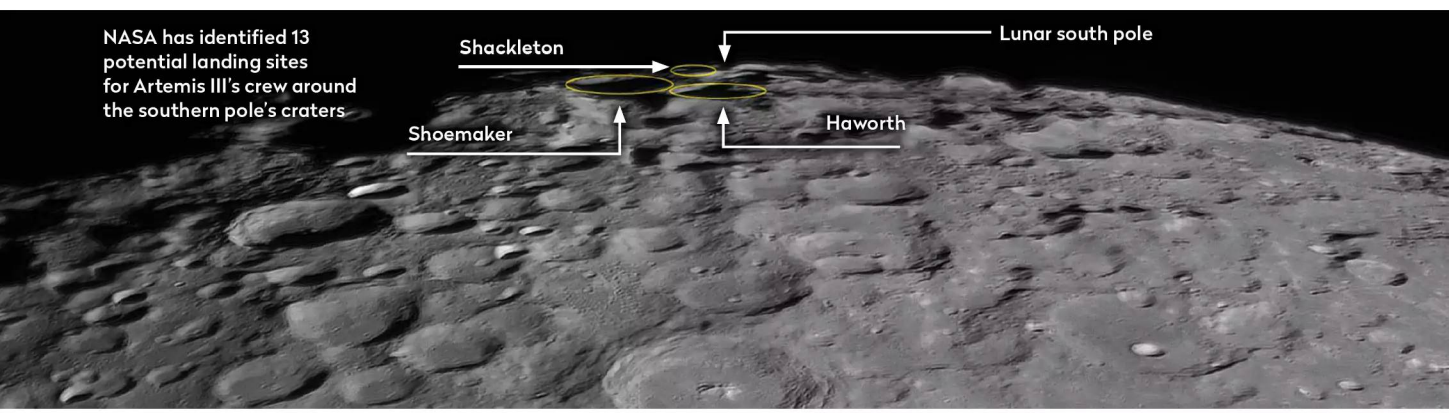
We may not have walked on the Moon for decades, but uncrewed missions have continued to explore it in our place. Today, the US Lunar Reconnaissance Orbiter circles the Moon capturing exquisitely detailed images, while recent Chinese missions have heralded a new era of robotic lunar surface exploration.

Among these is the Chang'e 3 mission, whose lander and rover touched down in 2013, and the Chang'e 4 mission that made the first landing on the lunar far side, in Von Kármán crater, in 2019. It was able to return high-resolution images of the area and deploy a rover to explore features up-close. Another success for the Chinese came in 2020, with the landing of Chang'e 5. It was deployed to a landing site in the northern Oceanus Procellarum or Ocean of Storms, where it gathered almost 2kg of samples that were returned to Earth by a spacecraft waiting in lunar orbit. Chang'e 4's landing site is hidden from view on the far side, but with a small telescope it is possible to see the wide region that Chang'e 5 studied. The landing site is a little way northeast of the fascinating volcanic feature Mons Rümker, which is well-positioned for observation on days around full Moon.



▼ The spacecraft drilled and scooped rock and soil from the region in late 2020




NASA has identified 13 potential landing sites for Artemis III's crew around the southern pole's craters
Shackleton
Lunar south pole
Shoemaker
Haworth

8. The lunar south pole

The first woman on the Moon will probably walk at its southern pole

We finish our observing tour with a look to the future. While the Moon will be largely unchanged for eons, it may once again become a destination that humans visit and explore. Certainly that's the hope of many space agencies and commercial entities around the world.

But such plans have been mooted for decades and deadlines all too often slip further beyond the horizon. Will the current push to return there, perhaps for longer periods, be the one that finally happens? If it is, there is one place that will be high on the list of possible landing sites: the lunar south pole region, near Shackleton crater. In fact, NASA has already picked out several potential landing spots in the region for its planned human landing mission, Artemis III. There, permanently shadowed craters offer the promise of water-ice, which could be used for making rocket fuel, while sunlit peaks and crater rims provide sites for bases with solar panels. For us amateur astronomers, the south pole region is also a fascinating area to take in at the eyepiece, with huge craters, mountains and undulating terrain creating a rich and captivating view in medium- to large-aperture telescopes using high magnification. Cast your eye over it when conditions are favourable, between 12 and 18 days after new Moon, because it could be a place where the next chapter in the Moon's history is about to be written...

Will Gater is an astronomy journalist, author and presenter

Look for the magnificent Sombrero Galaxy, M104, in the constellation of Virgo, the Virgin in the springtime months of March, April and May

Welcome to GALAXY SEASON

Stuart Atkinson is a lifelong amateur astronomer and author of 11 books on astronomy

For many astronomers, springtime means one thing – galaxies. **Stuart Atkinson** reveals this season's deep-sky highlights

When I was at school I was fascinated by space, but also by the weather. I devoured the library's science books, describing how the weather changed with the seasons. Those books depicted the seasons with delightfully sentimental illustrations. Spring was represented with lambs gambolling in fields of wild flowers; summer was a beach scene with children making sandcastles; autumn showed a child in a raincoat and wellies splashing through puddles; winter was a snowman, surrounded by a family dressed in scarves and gloves and a robin in a nearby holly tree. Eventually, I learned that the night sky has seasons too: as the months pass, amateur astronomers look at different celestial objects at different times of the year. In summer, we observe the misty band of the Milky Way and noctilucent clouds (NLCs). In autumn, we gaze again at the star-frothed spiral of the Andromeda Galaxy, M31, and frosty winter nights belong to Orion, its nebulae and glittering star clusters.

Spring is 'galaxy season', when telescopes swing towards a selection of constellations, hunting for the faraway galaxies that lie within them. Here, we look at why springtime is a boon for galaxy hunters, and highlight three constellations and a nearby galaxy cluster that contain great galactic targets to point your telescope at over the coming months. ▶

Why is springtime galaxy season?

Our planet's journey around the Sun provides us with an ever-changing view of the Universe

How can one time of year be better for observing galaxies than others? It's all to do with Earth's position in its orbit. During summer, we enjoy our best views of the Milky Way because that's when the Sun is farthest in our sky from the constellations that contain the brightest and most densely star-packed areas. In spring, Earth's position gives us our best view of the constellations that contain the most galaxies. This includes galactic clusters, where it's possible to observe several galaxies at the same time.

You'll get the most out of galaxy season with a telescope

Many observers look forward to spring because, compared to naked-eye star clusters like the Pleiades, M45, or bright nebulae such as the Orion Nebula, M42, the season's galaxies are challenging yet rewarding targets. Although some are big and bright enough to be seen through binoculars, most require a good telescope to view them at their best. Larger instruments under dark skies reveal the spiral arms and cores of a few, while through smaller telescopes most will resemble small grey smudges. For most observers, galaxy season is all about observing those smears through a telescope and being awed by these distant, colossal structures.

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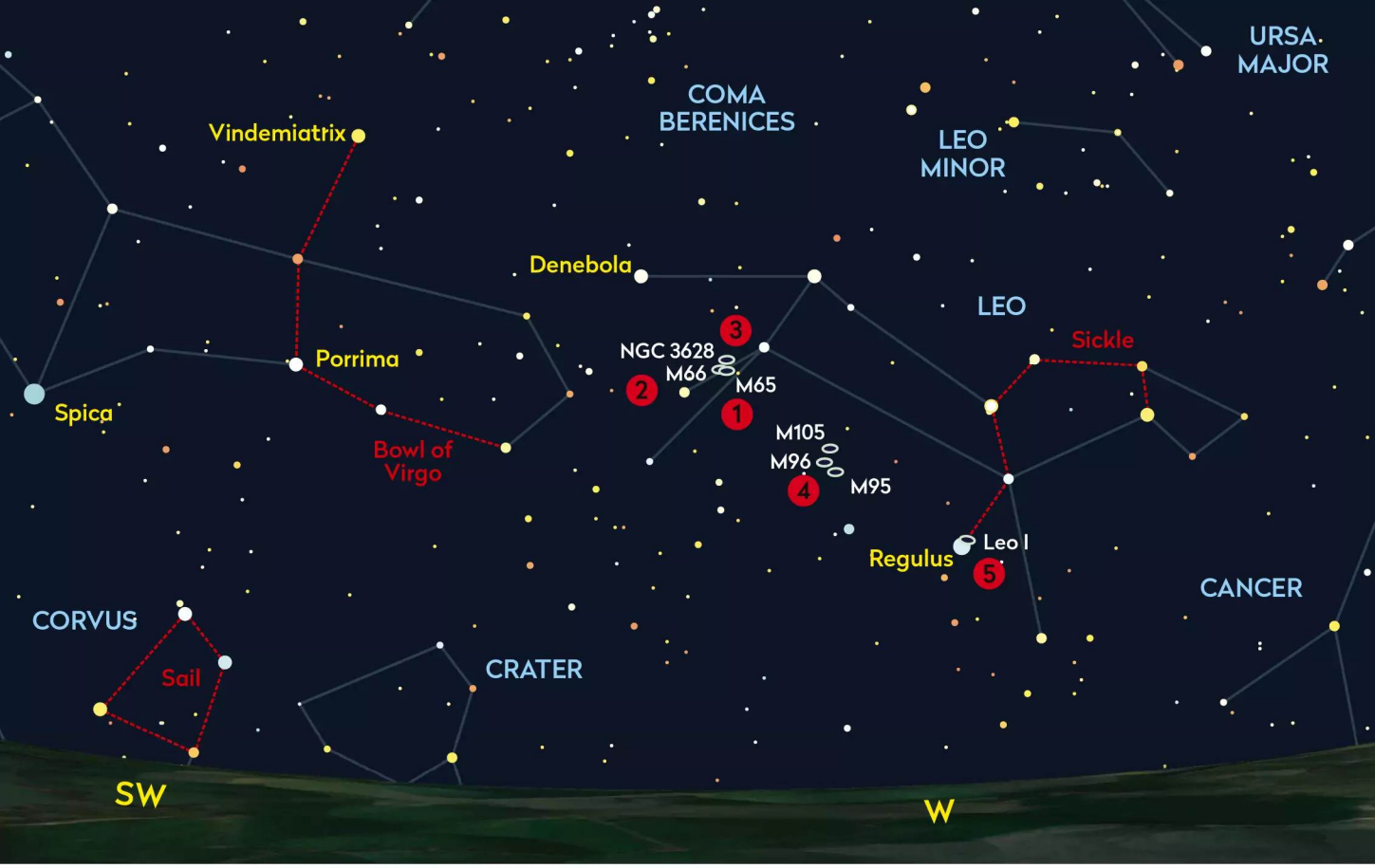
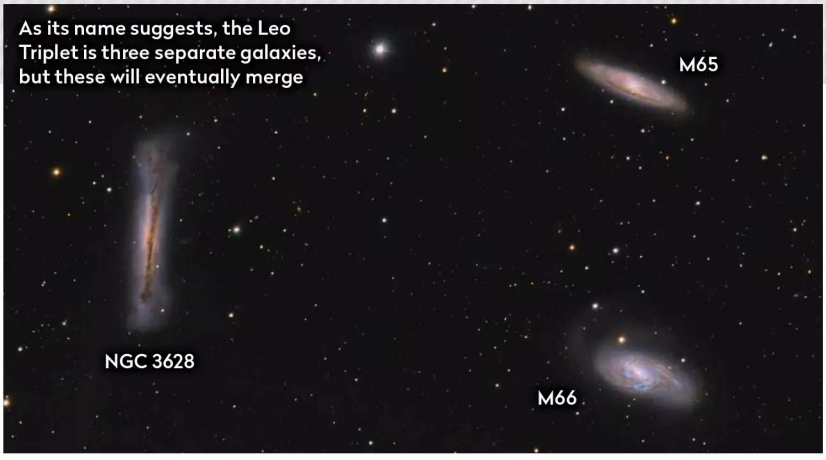


LEO

Sphinx-shaped Leo, the Lion is famous for its Sickle asterism, a pattern of six stars, including first-magnitude Regulus (Alpha (α) Leonis), that form the shape of a curved blade, although others see it as a back-to-front question mark. It also contains fascinating galaxies, including...



As its name suggests, the Leo Triplet is three separate galaxies, but these will eventually merge

1. M65

With a magnitude of +10.3, this spiral galaxy is 35 million lightyears away and is one member of the famous 'Leo Triplet', a trio of galaxies all visible in the same telescopic field of view. High magnifications reveal its tightly wound spiral arms and bright centre. It has a diameter of about 90,000 lightyears.

2. M66

The brightest of the Leo Triplet, this barred spiral galaxy's arms are among the brightest of any galaxy's. Shining at mag. +8.9, it's just visible through binoculars on a dark, Moon-free night, but you'll need a telescope to see its mottled arms. M66 lies 35 million lightyears away.

3. NGC 3628 - THE HAMBURGER GALAXY

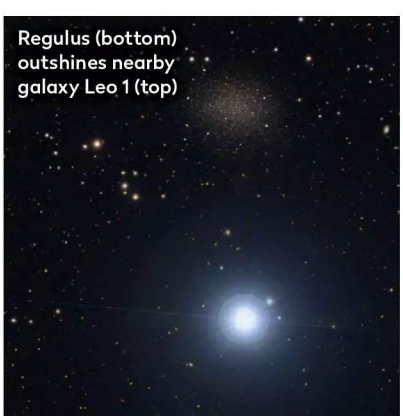
The faintest of the Leo Triplet, this galaxy appears edge-on from our perspective. It's a spiral galaxy with a broad, dark central dust lane, visible through large telescopes on nights of very good seeing.

4. M96

This spiral galaxy has a central dark dust lane crossing a very bright core. At mag. +10.1, it's visible in small telescopes, but with a larger instrument you'll also be able to see the faint spiral arm that curves away from it to the southeast.

5. LEO 1

If you fancy a challenge, this is it! Almost lost in the glare of nearby Regulus, Leo 1 is small, very diffuse and faint. Its magnitude of +11.2 means that only owners of large telescopes blessed with clear skies and no light pollution will see it clearly. Even then it will appear as a small smear of light in the eyepiece. But that smear of light is a satellite galaxy of our own, just like the much larger and brighter Magellanic Clouds that grace the southern sky. This makes it a must-see this galaxy season.


Regulus (bottom) outshines nearby galaxy Leo 1 (top)

CHARTS BY PETE LAWRENCE, CHRISTOPH KALTSEIS/CCDGUIDE.COM, BERNHARD HUBL/CCDGUIDE.COM, ROBERT POLZL/CCDGUIDE.COM

COMA BERENICES

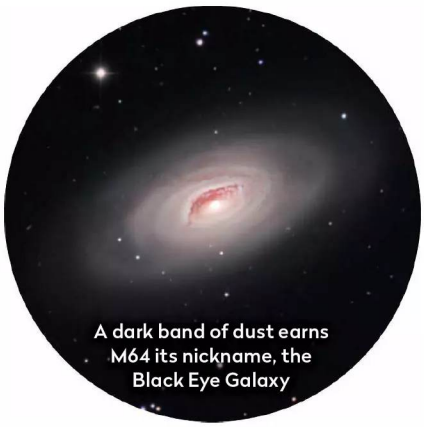
Coma Berenices – or Berenice's hair – is one of those constellations that looks absolutely nothing like the object it's supposed to represent. You'd need the imagination of Steven Spielberg to see 'maiden's hair' when you look at this spattering of faint stars between Leo and the Plough. But swing a telescope towards it and you'll see lots of intriguing galaxies, including...

1. M64 - THE BLACK EYE GALAXY

One of the most famous galaxies in the sky, eighth-magnitude M64 is bright enough to see as a small, misty patch in binoculars, but you'll need a telescope to appreciate how it got its strange nickname. Under high magnification you'll see a prominent dark dust lane – discovered by William Herschel – crossing the lower part of its bright central core.

2. NGC 4565 - THE NEEDLE GALAXY

One of the most beautiful galaxies visible during galaxy season, NGC 4565 is around 30 million lightyears away. It's an edge-on spiral and large instruments give wonderful views of its bright, round core and the dark dust lane that crosses it. Many observers have wondered how Charles Messier missed spotting this mag. +9.6 treat, which is often used to illustrate how the Milky Way would appear to an observer on a distant world.



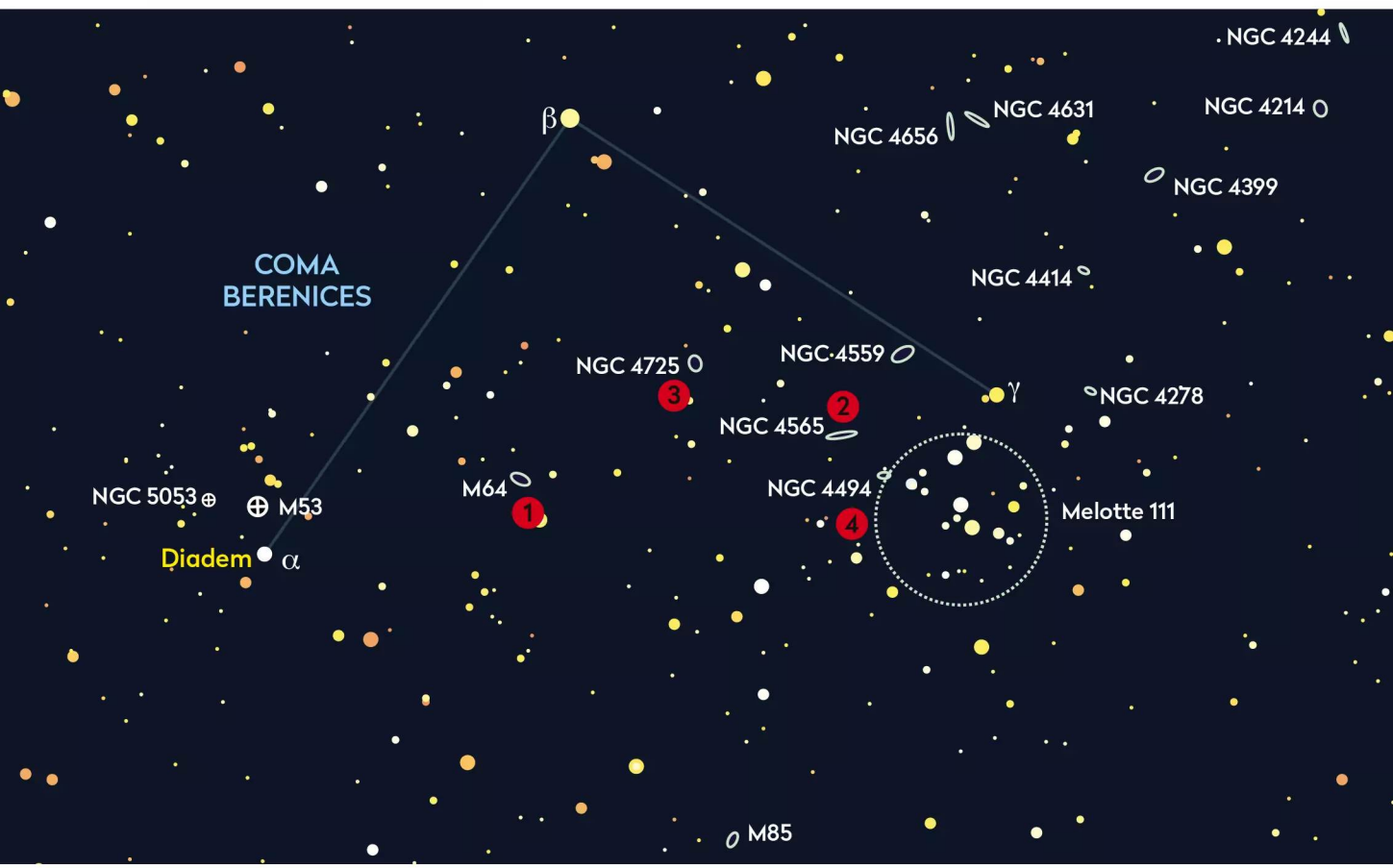
A dark band of dust earns M64 its nickname, the Black Eye Galaxy

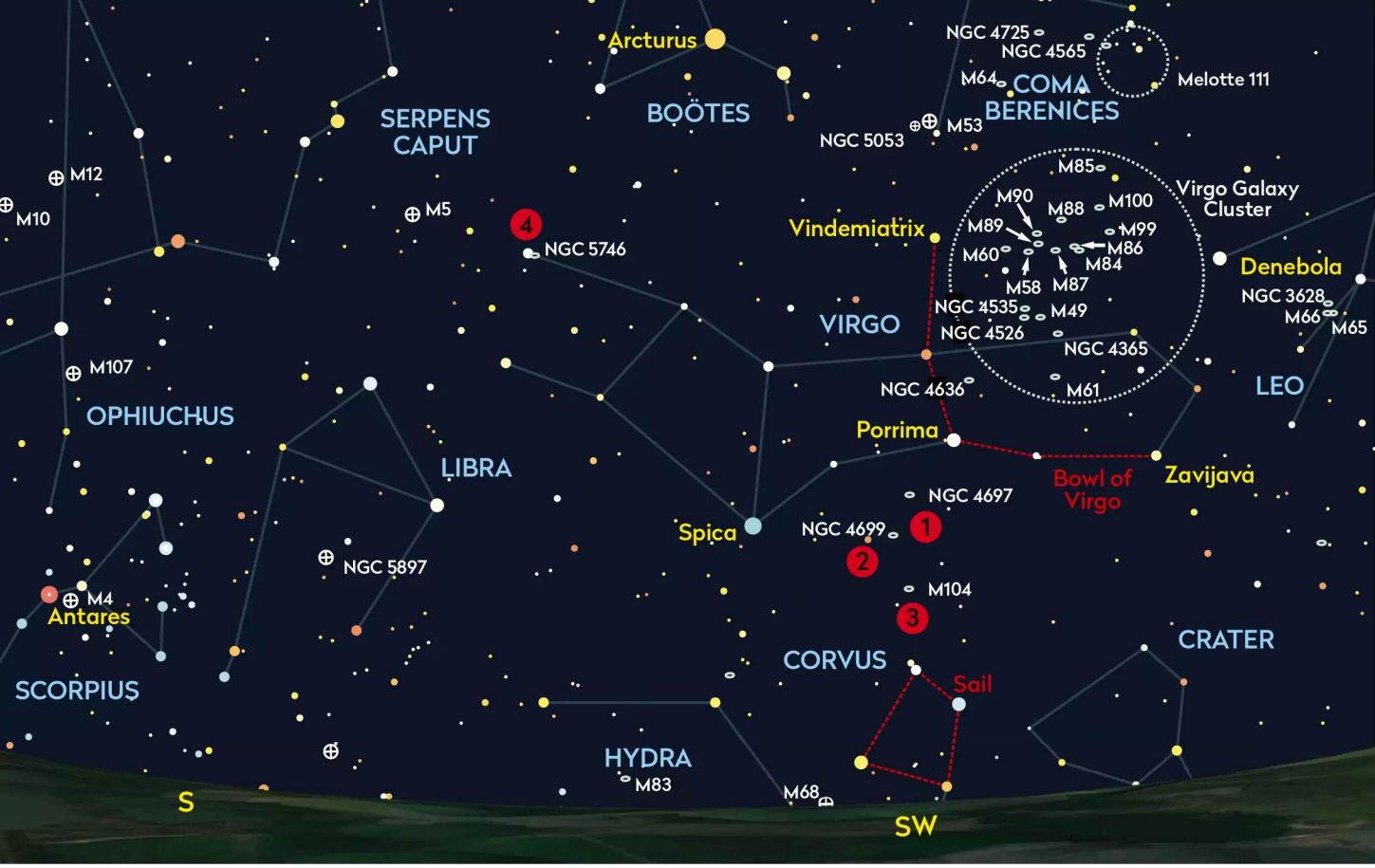
3. NGC 4725

This eighth-magnitude barred spiral galaxy is 39 million lightyears away. Visible in binoculars as a small, oval-shaped smudge, it has been compared to a miniature version of M81. High magnification shows hints of the single spiral arm that curls away from its central bar.

4. NGC 4494

A mag. +9.7 elliptical galaxy, NGC 4494 is relatively unremarkable, visually, but it makes our list because it's a good example of what most galaxies actually look like when seen through a telescope. Galaxies that look like Catherine wheels, with bright, star-frothed spiral arms, are the exception, and the vast majority appear more like little NGC 4494 – a small, faint smudge of pale grey. ▶





VIRGO

Like neighbouring Leo, the constellation of Virgo, the Virgin straddles the ecliptic, so it is often visited by the Moon and planets in Earth's night sky. Although Virgo has quite an abstract shape, it contains many galaxies, including some of the best-known in the sky, such as...

1. NGC 4697

This mag. +10.9 elliptical galaxy appears as a misty, flattened disc in a large telescope. Like most ellipticals, it has no outstanding visible features or structures, and really is a hazy ball of pale, ancient stars. Astronomers have detected a huge black hole at its centre, with a mass between 50 and 100 million times greater than our Sun.

2. NGC 4699

This spiral galaxy is 65 million lightyears distant and has a magnitude of +9.4. Large telescopes show it as an almost flower-like object, composed of multiple faint rings and arcs. It is around 85,000 lightyears across and was discovered by William Herschel in 1786.

3. M104 - THE SOMBRERO GALAXY

With a magnitude of +8.0, this famous galaxy can be seen easily through binoculars on a clear, dark night, looking like a small oval patch of grey light. Look at it through a telescope, however, and you'll see why it's compared to a Sombrero hat: it's an edge-on spiral galaxy with a bright and unusually large central bulge that's crossed by a thin, dark dust lane. We now know that a 1 billion solar-mass supermassive black hole lurks at its centre.

▲ NGC 4699's many rings and arc give it the appearance of a flower

▲ A larger telescope is needed to see NGC 5746, which is edge-on from our viewpoint

4. NGC 5746

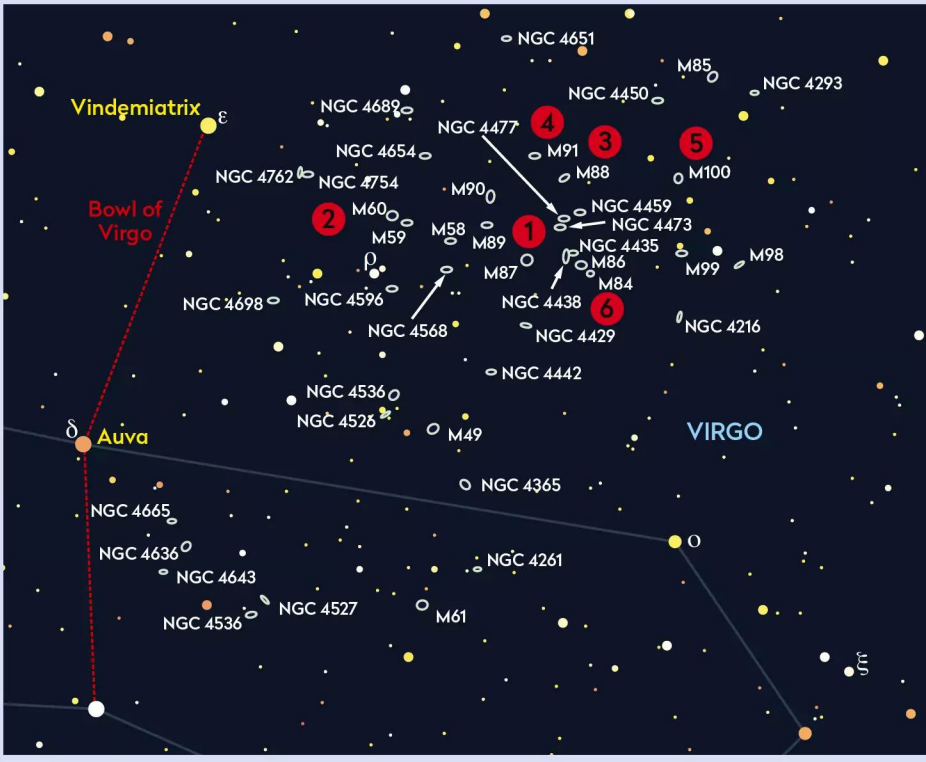
NGC 5746 is a typical edge-on spiral galaxy. It has a bright central bulge that's bisected by a dark lane of dust. With a magnitude of +10.0, it's too faint to be seen in binoculars and is little more than a faint misty line in small telescopes, making it a target that's best suited to larger instruments.

CHARTS BY PETE LAWRENCE, RICK J/WWW.CLOUDYNIGHTS.COM, OLIVER SCHNEIDER/CCDGUIDE.COM, JOHANNES SCHEDLER/CCDGUIDE.COM

The Virgo Cluster

Take a closer look at the constellation of Virgo and you'll spot this wonderful cluster of galaxies full of deep-sky treats

Just as stars form into clusters, so galaxies do too. These truly enormous structures, millions of lightyears across, contain vast numbers of galaxies of all shapes and sizes, moving through space together like snowflakes in a blizzard. There are several such clusters, each containing many deep-sky objects, but the Virgo Cluster, a spray of more than a thousand galaxies, is in a class of its own.



1. M87 – VIRGO A

The brightest member of the Virgo Cluster, this elliptical galaxy floats at a distance of 55 million lightyears and has a magnitude of +8.6, making it easily visible through binoculars. With a telescope it will appear as an almost circular hazy patch. Images taken with the Hubble Space Telescope show a pair of high-energy jets shooting out of M87 like lighthouse beams. M87 is a huge galaxy, perhaps as much as half a million lightyears wide, and is surrounded by more than 12,000 globular clusters, compared to the 200 or so that orbit the Milky Way.

2. M60

A true monster of a galaxy, this giant elliptical contains around a trillion stars. Shining at mag. +9.8, it's visible as a tiny smudge through binoculars, but large telescopes will clearly reveal its round shape and also its close visual companion, the spiral galaxy NGC 4647, which is about two-thirds the size of M60. Discovered in 1779 by the German astronomer Johann Gottfried Köhler, M60 lies 54 million lightyears away from Earth.

3. M88

Mag. +9.3 M88 is a giant spiral galaxy. Through a telescope it appears as a misty oval smudge, which some observers think resembles a shrunken version of M31, the Andromeda Galaxy. Large instruments reveal hints of mottling within this compact spiral's tightly curved arms. Although it is part of the Virgo Cluster, it's located in nearby Coma Berenices.

NGC 4438 (left) and NGC 4435 – together known as the Eyes

4. M91

This 11th magnitude galaxy is one of the faintest objects in Messier's catalogue, and is 60 million lightyears away. It's a beautiful sight in a large scope, with two spiral arms curving away from its central bar, but you'll only see those with high magnification under a truly dark sky. It's also located in Coma Berenices.

5. M100

Another beautiful galaxy, M100 has a magnitude of +9.3 and is 52 million lightyears away. Small telescopes show its bright centre and oval shape, while larger instruments reveal tantalising hints of its tight spiral arms.

6. NGC 4438/NGC 4435

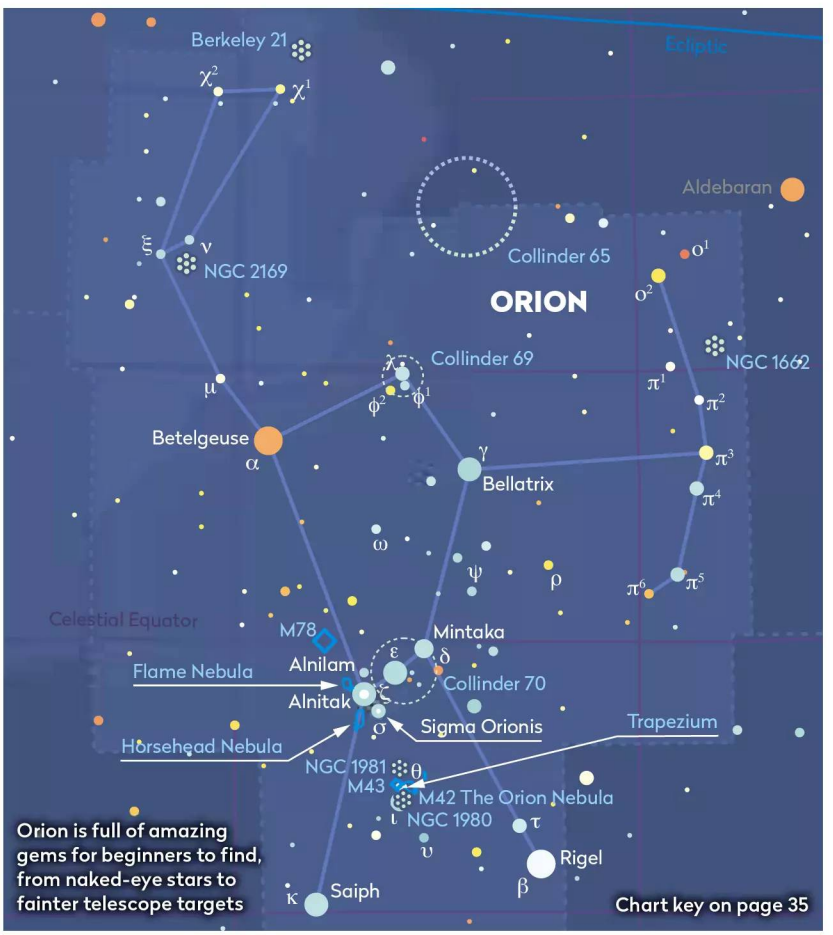
This close pair of spiral galaxies was nicknamed The Eyes by LS Copeland, who thought it looked like a pair of eyes staring back at him from the depths of space. Together, they form part of the Markarian's Chain asterism, a trail of galaxies that meanders across the Coma Berenices/Virgo border. At mag. +10.6, NGC 4438 is the fainter of the pair, almost a magnitude fainter than its close neighbour NGC 4435.

A tour of ORION

Katrin Raynor reveals the stunning sights anyone can enjoy in this winter constellation

Winter is the best time of year for newcomers to astronomy. It gets darker earlier, the atmosphere is clearer and some of the best constellations are visible in the night sky. Within these constellations you can see deep-sky objects such as galaxies, star clusters and nebulae.

Orion is one such constellation. It's a great starting point for beginners because it is instantly recognisable in the winter sky and contains wonderful stars and deep-sky objects that demand closer inspection. Here we'll explore some of Orion's astronomical treasures and how you can view them.



Orion is full of amazing gems for beginners to find, from naked-eye stars to fainter telescope targets

Orion's Belt

Orion is easy to spot because of the three stars in an almost straight line that run through its middle. These are (left to right) Alnitak, Alnilam and Mintaka, and they form Orion's Belt, an asterism (pattern of stars) within the larger constellation. Alnitak is a triple star system, Alnilam is 375,000 times brighter than the Sun and Mintaka is a binary star system (two stars orbiting each other). Orion's Belt forms part of a larger open cluster known as Collinder 70.

Betelgeuse and Rigel

At opposite corners of the figure of Orion are its two brightest stars. Betelgeuse and Rigel are winter night-sky celebrities. Betelgeuse is a red supergiant with an orange hue that is greatly enhanced through binoculars and telescopes. A thousand times bigger than our own Sun, if you placed Betelgeuse in the centre of our Solar System it would swallow up Jupiter. In the far future, Betelgeuse will explode as a supernova, and will be so bright it will cast shadows on the ground. In contrast, icy-blue Rigel is a blue supergiant star 70,000 times more luminous than our own Sun. At a magnitude of +0.12, it is the seventh-brightest star in the night sky.

Bellatrix

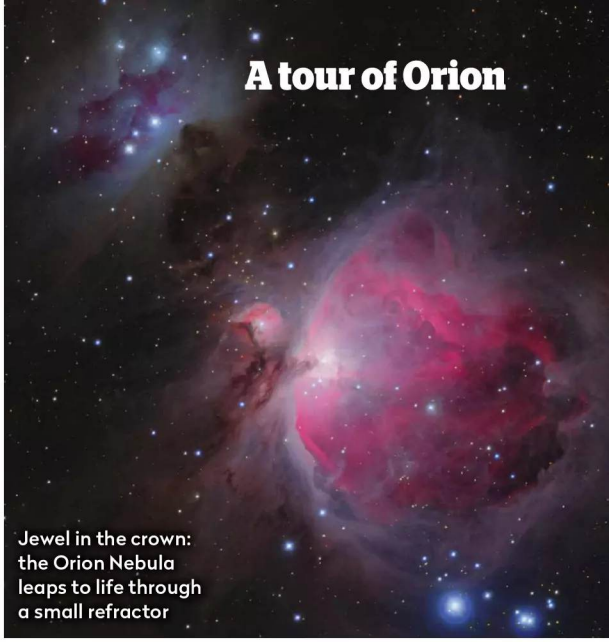
The third-brightest star in Orion, Bellatrix lies in the top right corner, 5° to the west of Betelgeuse. Its name means 'female warrior' in Latin. This blue giant star, almost six times the Sun's diameter, is just 25 million years old. Shining at mag. +1.6, it is the 25th-brightest star in the sky.

Saiph

The faintest of the four corner stars of Orion, blue-white Saiph – from the Arabic word for 'sword' – is another

CHART BY PETE LAWRENCE, EERIK/ISTOCK/GETTY IMAGES, CEDIC TEAM/CHRISTOPH KALTSEIS/CCDGUIDE.COM, FRANZ KLAUSER/CCDGUIDE.COM, DAVIDHAJNAL/ISTOCK/GETTY IMAGES

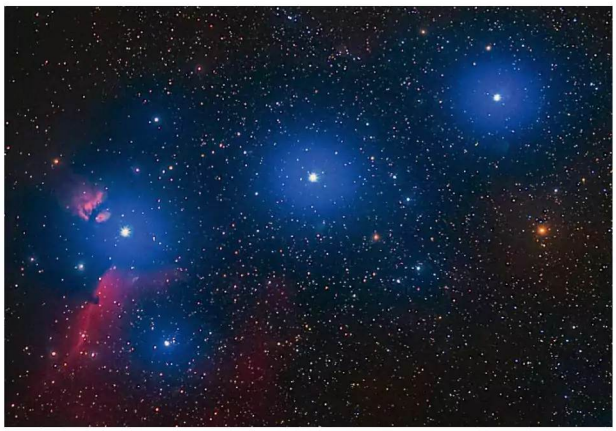
The figure of the mighty hunter Orion is unmistakable in the winter sky



A tour of Orion

Jewel in the crown: the Orion Nebula leaps to life through a small refractor

▲ The dusty tendrils of the Flame Nebula are a little tricky thanks to Alnitak's glare, and calls for larger instruments and dark skies



▲ Orion's famous Belt (left to right): Alnitak, Alnilam and Mintaka. Bump up the aperture to see the iconic Horsehead Nebula (left)

supergiant. Although it's 56,000 times more luminous than our own Sun, its distance of around 650 lightyears reduces it to mag. +2 in our sky.

The Orion Nebula

The Orion Nebula, M42, lies in the centre of Orion's Sword, a short vertical line of three fainter stars that hangs from Orion's Belt. It looks like the middle 'star' of the sword to the naked eye, a little fuzzier than the stars above and below it. Composed of dust and gas, and located only 1,344 lightyears away, it can be seen with the naked eye, so it is a perfect pitstop for beginners. A pair of 10x50 binoculars will enhance the nebula, while a small telescope will bring out dark and light patches.

Trapezium Cluster

Embedded in the heart of the Orion Nebula, the Trapezium Cluster is a tight open cluster of stars born from the surrounding dust and gas. The cluster appears as a single starry point through binoculars, but its four brightest stars are revealed through medium-aperture telescopes. Through a large telescope, it is a stunning sight, illuminating the gas and dust behind and around it.

The Horsehead Nebula

The Horsehead Nebula is a 'dark nebula' – a cloud of dust silhouetted against brighter gas behind it. It's just beneath Alnitak, the star shining on the eastern end of Orion's Belt. If you want to see it you'll need a dark sky, a high-power eyepiece in your telescope and a Moon-free night. You'll see the nebula as a dark notch on the lighter background. Under perfect conditions, it looks like a knight chess piece.

The Flame Nebula

Somewhat overshadowed by its bigger and more famous neighbours, the Orion and Horsehead Nebulae, the Flame is a cloud of dust and gas illuminated by Belt star Alnitak. Visible as a roughly cone-shaped smudge through small telescopes, larger instruments show it cut down the middle by a dark dust lane. The nebula is a great photographic target: even short unguided exposures with a DSLR camera on a tripod will record it well.

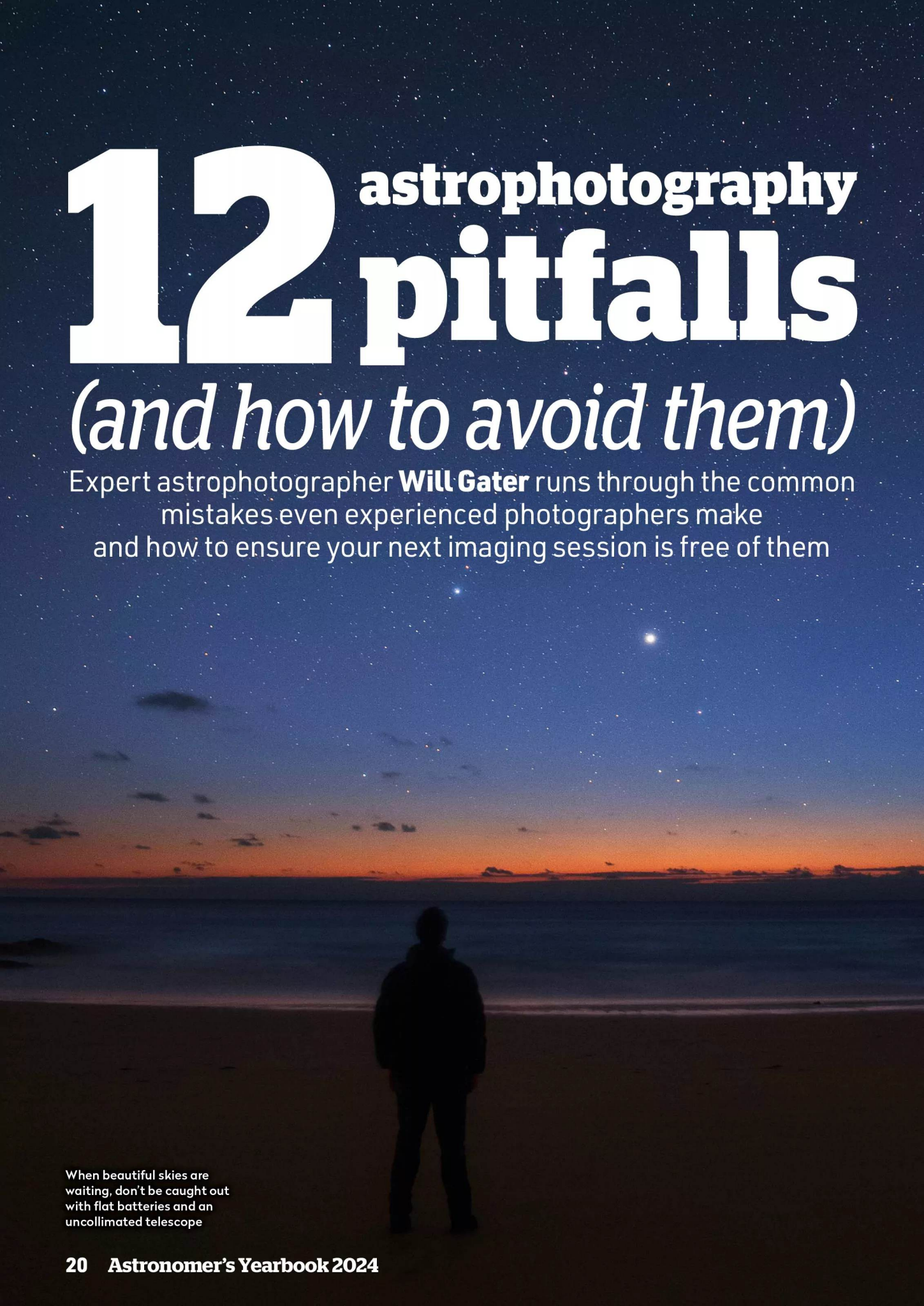
Sigma Orionis

At the eastern end of Orion's Belt, just south of Alnitak, this fourth-magnitude multiple star is the brightest member of a young open star cluster sprinkled across the same telescopic field of view as the Horsehead Nebula. The cluster has several dozen members bright enough to be seen through a telescope. Sigma itself is a system of five stars and even a small telescope will resolve its brightest components, making it a popular target for backyard observers.

Katrin Raynor is an astronomy writer and a Fellow of the Royal Astronomical Society

12 astrophotography pitfalls *(and how to avoid them)*

Expert astrophotographer **Will Gater** runs through the common mistakes even experienced photographers make and how to ensure your next imaging session is free of them



When beautiful skies are waiting, don't be caught out with flat batteries and an uncollimated telescope

Starting out in astrophotography is an exciting, but often bewildering, experience. When you think about it, it's probably one of the strangest types of photography out there. You're going out late at night when it's dark – sometimes in remote spots – trying to capture a picture of something that's not just really distant but extraordinarily faint by any normal photographic standard. Oh and, by the way, not only will the entire sky be moving while you're doing this, but the atmosphere you're shooting through will be wobbling too. And all that is before you have even considered the prospect of actually processing the data you have captured.

It's no wonder there are so many slip-ups that are easy to make. In this piece I'm going to look at 12 common imaging mistakes and how you can avoid making them. I've made every single one of them myself at one point or another, and I'm sure in time you'll find new and interesting ones of your own too – the astrophotography learning process is one that never ends!

Will Gater is an astronomy journalist and science presenter. His latest book, *The Mysteries of the Universe*, is published by DK

1. Not getting the focus right and capturing soft data

The exaggerated spikes created by a Bahtinov mask are another way to achieve sharp focus

As imagers we often dedicate tens of hours, if not more, to setting up a scope and mount, getting the auto-guiding or tracking just right and then carefully processing the data we capture. But the quality of the final image all hinges on a pivotal process that can all too easily be rushed: getting the optics *perfectly* focused. If you're not using a focusing aid – such as a Bahtinov mask – time spent carefully confirming focus will never be wasted. When doing this, try to slowly adjust the focuser a little way past what you think is the focus point, and then gradually return back through to the other 'side' of that point until you're absolutely sure where it is.

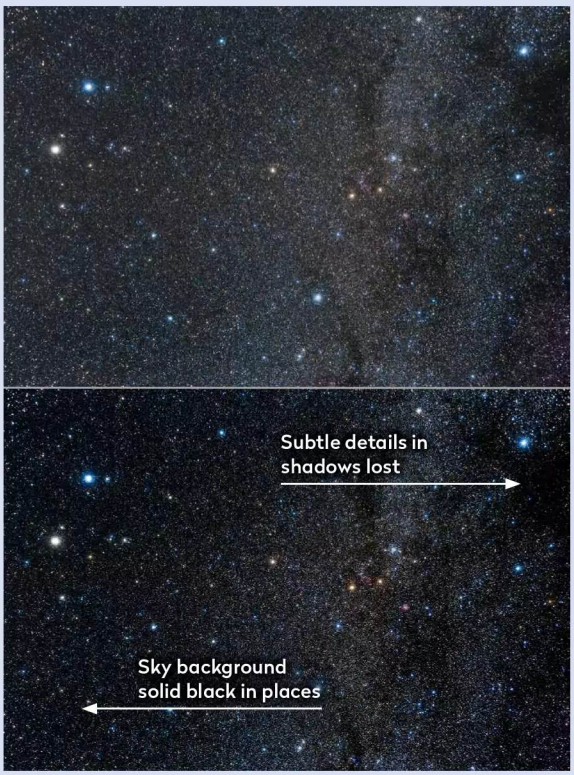
If you're using a live preview screen on a camera, check focus on several medium-bright stars in the frame, as sometimes it's not easy to accurately judge when a bright star is at its smallest and, therefore, sharpest. And once you're focused, continue to check that the optics you're using *remain* in focus throughout your imaging session. Did you very slightly nudge the focus ring on the lens as you manoeuvred the camera around, for example? Has the focus of your imaging system changed minutely as the air temperature has varied? Did a filter change alter the focus point? Athough they can be time-consuming, all of these little checks, will ensure the data you capture is the clearest and crispest it can be.

Your scope needs time to adjust to outside temperatures

2. Not letting optics cool

With clear skies a rarity in the UK, it's understandable you'd want to start imaging as soon as you've got your kit outside. However, it's essential to allow a telescope's optics to cool down to close to the ambient air temperature before you do, particularly in the case of high-resolution lunar and planetary imaging. This is because air currents inside a warm telescope can degrade any data you capture, making the final image softer. If it is safe to and there's no risk of inclement weather (and there's a clear night ahead), put the covered telescope outdoors in advance of your imaging session and you'll get better results. ▶

ALL PICTURES: WILL GATER



▲ **The same data, processed differently. In the bottom image the black point has been 'clipped' causing a loss of detail**

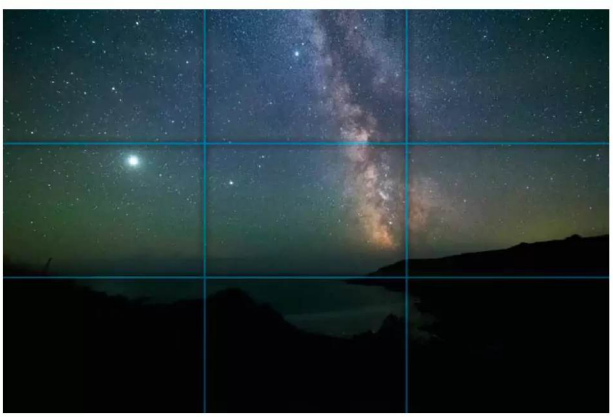
3. Clipping the black point in post-processing

Here we come to our first 'mistake' which is concerned with something a little more aesthetic than practical, and it centres on how we wish to represent space in our images. When it comes to the depictions of areas around celestial targets, or the night sky more generally, I'm of the view that – in most kinds of astrophoto – space, and the night sky, should never be *completely* black. The sky, the Galaxy and beyond is full of the diffuse light of stars and other sources, and so to make the background of an astro image a solid black doesn't seem quite right.

Now you may disagree on aesthetic or artistic grounds, in which case I very much respect your choice, but if you've never considered this before, check that you're not inadvertently 'clipping' the black point. This is where the contrast of an astrophoto is tweaked to a stage where, when you inspect the 'levels' tool of an image editor like Photoshop or GIMP, the so-called 'black point' arrow slider cuts off the left edge of the levels histogram. This results in subtle, darker shades in the picture being lost and appearing simply as solid black. This is something to watch out for in deep-sky and nightscape imaging in particular, as it can lead to a loss of detail in shadowy features like dark nebulae.

4. Not planning your composition

Composition is one of the easiest things to overlook in imaging, yet it has a huge effect on the impact of an astrophoto. If you're setting up a shot, spend some time thinking about how you'll draw the viewer's eye into the picture and how the object or scene you're shooting is placed in the frame. For nightscape-style work, with a horizon and foreground, it can be useful to think about the 'rule of thirds' principle, where you arrange features or landmarks into three zones, with key features that you want to highlight placed close to the points where a set of lines cross near the centre of the shot (see below). For deep-sky imaging, offsetting an object from the centre of the frame will often create a more engaging composition than simply placing it right in the middle.



▲ **Imagine the scene divided up as above and position your key elements at or near the lines and intersections of the grid**

5. Using poorly collimated optics

▲ **Targets won't appear sharp if your mirrors are out of alignment**

If you're imaging with a reflecting telescope, it's really important to regularly check the collimation – or alignment – of its optics if you want to take the best images you can. This is especially important when carrying out long focal-length, high frame-rate imaging of the Moon and planets. There are numerous online collimation guides for a variety of different telescope designs, and experienced members of your local astronomical society may also be able to offer advice if you get stuck.

WILL GATER X 5, STEVE MARSH

6. Over-sharpening your data

When you've spent so much time collecting precious imaging data it's tempting to push it as hard as you can in the later post-processing stages: you naturally want to see if you can get as much detail as possible out, but it's remarkably easy to sometimes take it a step too far. Often you might not even notice what's happened in that moment when you're sitting at your computer, deep in thought about the processing. I know I've certainly done it with my own pictures, and it's only when I've posted the image online, or seen it on my website, that I think, "Hang on, that's a bit overdone".

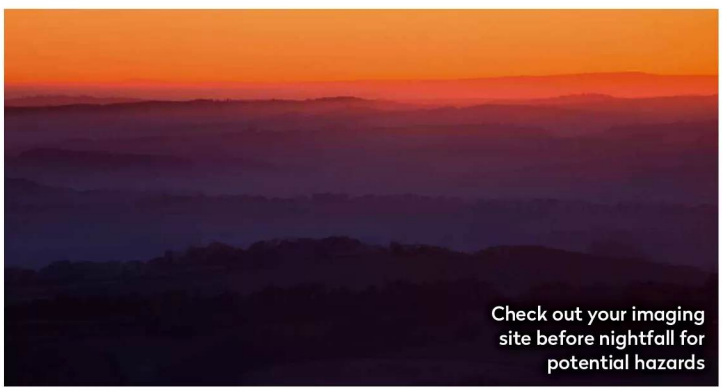
Although one can push data too far in any field of astrophotography, I find it's particularly easy to do in areas where we're dealing with data that, from the beginning, has to be refined and sharpened to make fine details visible, like high-frame-rate 'lucky' imaging of the Moon and planets. Here – when you're wavelet sharpening or applying an 'unsharp mask' later in an image editor – nudging the sliders a little too much can quickly result in sharpening artefacts, like dark borders around features or a general 'crunchy' look.

To be vigilant, I find it's good to make adjustments incrementally, going back and forth to check each step, and then leave the image for a while. When you come back to it with fresh eyes and compare it to earlier iterations, you'll see if you've really made the enhancements you want.

▲ It's all too easy to over-sharpen objects like lunar craters. Avoid that harsh and 'crunchy' look (right) by making adjustments incrementally and taking breaks from your processing

7. Not recceing a site before visiting at night

If you're planning on travelling to a new dark-sky spot or one you haven't visited for a while, recce the site beforehand in daylight. Not only should this help you identify safety issues and avoid hazards, but if you're a nightscape imager it'll also give you a chance to scout out compositions. ▶



Check out your imaging site before nightfall for potential hazards

Shooting in RAW captures far more data, which you can then reprocess time and again

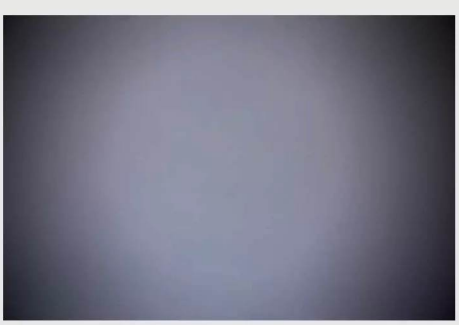
8. Not shooting in RAW with your DSLR

One of my biggest regrets from my early days of digital astrophotography was not shooting in RAW format when using my first DSLR. While I can go back to the vast majority of the DSLR images in my archives and process the RAW files from scratch again – with the benefit of experience and new processing software or techniques – the images from those early years are just standard JPEG files, which by their nature are compressed. The RAW format files preserve much more data, so it's similar to having a digital negative, while if you try to process an old JPEG, you're essentially working with an inferior copy of the full data captured by the camera. Even if you don't have the software or intention to process RAW files now, I'd still recommend shooting in RAW, as years down the line you may wish to revisit the data to see what's lurking in it.

9. Not gathering calibration files

In a similar vein to neglecting to shoot in RAW, is the issue of capturing calibration files. This is mainly applicable to deep-sky imaging with a telescope or long lens, and it's one of those occasions when a little effort can have a big effect on an image. In basic terms there are two kinds of calibration files that are worth capturing as a beginner: 'flats' and 'dark frames'.

Flats, or flat fields, are images used to capture the optical defects in the imaging system, such as dust shadows on the camera sensor and vignetting (the darkening in the periphery of a frame caused by the optical housing of the telescope). Flats can be captured using a clean, white cloth or pillowcase carefully placed over the front aperture of your telescope; you then shine a torch onto the cloth and take a well-exposed image.



▲ Taking flat-field frames lets you remove defects such as vignetting and dust shadows

Dark frames are exposures taken under the same settings and conditions as regular sub-exposures, except the lens cap or telescope aperture is covered so as to only record the camera noise. In both cases these frames are then subtracted by software when it comes to processing the data, and the calibration they provide will substantially improve the quality of even a basic deep-sky photo.

ALL PICTURES: WILL GATER

Flat batteries, full SD cards and missing kit can all ruin your imaging trip

10. Not preparing contingency kit

There's nothing that ruins a night of astrophotography like turning up to an observing site with a camera that doesn't have a memory card in it or that has a flat set of batteries. My greatest triumph in this area was driving over an hour to a dark-sky spot with my entire imaging rig except the small – but *absolutely vital* – baseplate that holds the DSLR to the tripod head. It's so easily done. Alarm reminders on my phone throughout the 24 hours before an imaging trip are one way I now build in contingencies to avoid these things happening, as they're harder to forget or overlook than a physical checklist.

11. Forgetting dew protection

If the atmospheric conditions are right, dew forming on the exposed surfaces of camera lenses and other optics can stop an imaging session in its tracks, sometimes over the course of taking just a few sub-exposures. If you've spent a long time setting up or waiting for skies to clear, this can be really demoralising, so it's good to be vigilant. What's more, on some nights even dew shields won't be enough to stop moisture from forming on a telescope or camera lens. There are many active dew prevention systems on the market. These typically work by wrapping around the telescope tube or lens and giving off a very gentle heat, which inhibits the formation of dew on the optics. It's worthwhile investigating even a basic system, as it should give you several happy hours of dew-free data capture.

A lens warmer will keep dew at bay and stop your lens from fogging up

12. Applying excessive noise reduction

I'll caveat this last point by saying that there's no 'right' answer and what follows is my opinion, but it is something that beginner imagers are perhaps being too hard on themselves about, thinking they need to make their data look 'perfect'. When I look at astrophotos online I often see some that have had very strong noise reduction filters applied, giving the shot a really smoothed look. Personally, I'm not bothered by a little noise in an image and I'd much prefer it over a highly smoothed background – in some ways the noise is part of the 'story' of the shot. So if you're tempted to massively crank up the noise reduction filter, maybe, instead, think about what leaving some of it in will bring to the picture.

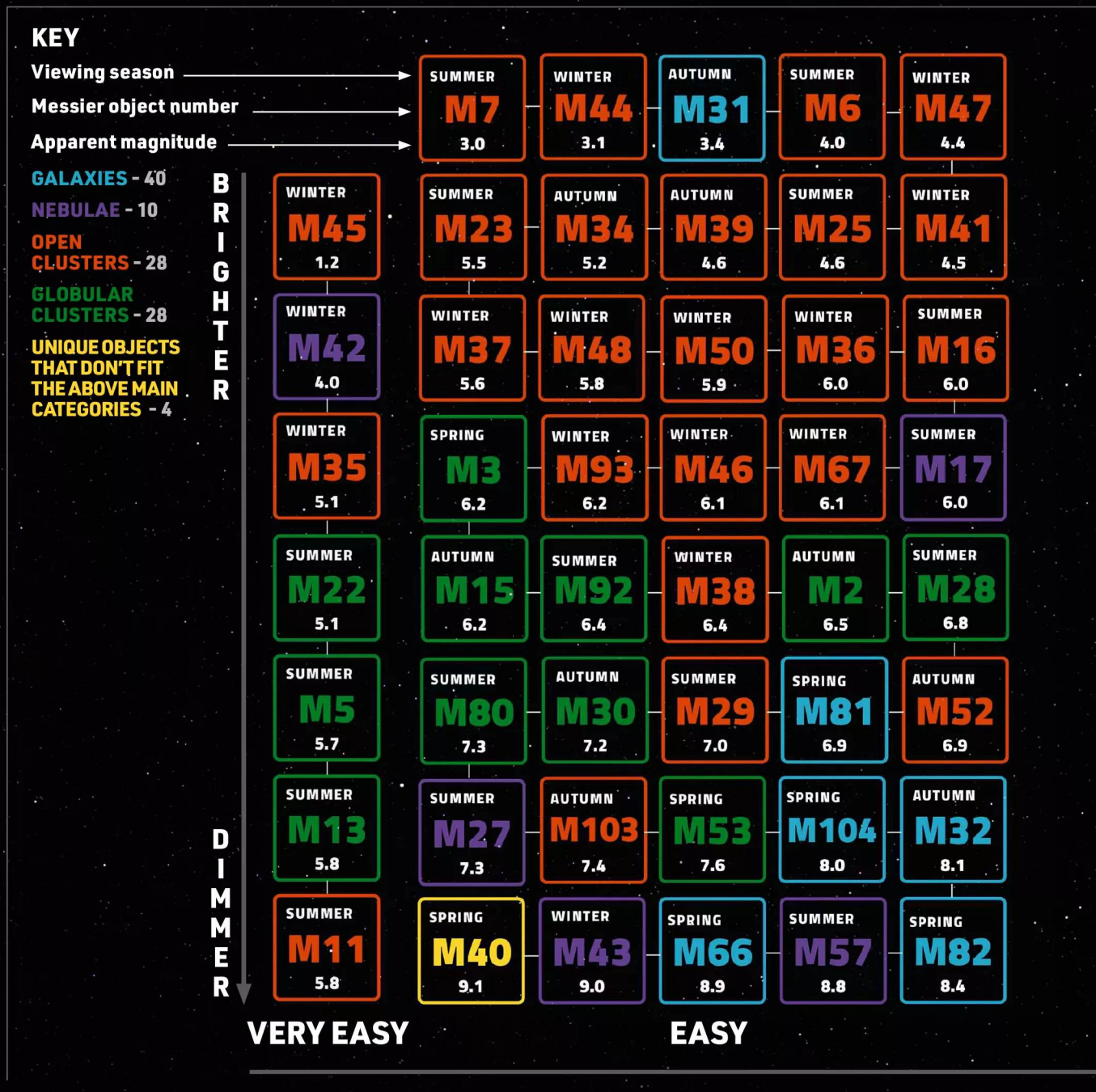
▶ This image of the Lagoon Nebula shows how very strong noise reduction (left-hand side) can make for overly smoothed results

The periodic table of Messier objects

Observing deep-sky objects is now a little bit easier thanks to **Tom Urbain's** at-a-glance guide to the targets of the Messier Catalogue

Charles Messier began his catalogue of observing targets in the mid-18th century to list items that would distract him and his assistant, Pierre Méchain, from their real aim of discovering comets.

In the centuries since, the targets listed in the Messier Catalogue have undoubtedly become the most observed deep-sky objects in the night sky by amateur astronomers and astrophotographers.



TOM URBAIN. GRAPHIC CREATOR: STARLUST.ORG. DATA SOURCE: TONY FLANDERS

The periodic table of Messier objects

When first published in 1781, the catalogue contained 103 objects. But observations in the 20th century by French astronomers identified a further seven objects, bringing the catalogue to today's total of 110 targets.

To present this quantity of intriguing astronomical objects in a more understandable way, amateur astronomer Tom Urbain has transformed the list into a periodic table.

"There are quite a lot of Messier objects, so I created the infographic to visually organise them into five different groups according to viewing difficulty, from very easy to very hard," says the UK-based astro imager. "I based this on using a mid-range telescope, such as a refractor of 8-inch aperture."

"Each cell contains the Messier object's number, the best viewing season and the apparent magnitude," says Tom. "The cells are also colour-coded depending on the object type, so it's easy to see which is a galaxy, a nebula, an open cluster or a globular cluster. Within each difficulty group, the objects are also organised from brightest at the top to dimmest at the bottom."

The graphic offers structure to the challenge of finding and observing the Messier objects. "It makes the 'trial and error' phase that we all go through a little easier when starting out," says Tom. "Beginners can therefore refrain from trying to observe very faint Messier objects with a 4- or 6-inch telescope and wondering what went wrong when they can't see anything."

	SUMMER M24 3.1	SUMMER M8 6	SUMMER M21 5.9	SUMMER M62 6.5	SUMMER M4 5.6	AUTUMN M33 5.7	SUMMER M20 6.3		
SUMMER M69 7.6	SUMMER M18 6.9	SUMMER M19 6.8	SUMMER M12 6.7	SUMMER M10 6.6	SPRING M83 7.5	SUMMER M55 6.3	SPRING M68 7.8		
SUMMER M14 7.6	SUMMER M54 7.6	SUMMER M9 7.7	WINTER M79 7.7	SUMMER M70 7.9	SUMMER M107 7.9	AUTUMN M110 8.1	SPRING M101 7.9		
SUMMER M56 8.3	WINTER M78 8.3	SPRING M94 8.2	SUMMER M71 8.2	SUMMER M26 8.0	SPRING M90 9.5	SPRING M106 8.4	SPRING M100 9.4		
WINTER M1 8.4	SPRING M51 8.4	SPRING M49 8.4	SUMMER M75 8.5	SPRING M64 8.5	SUMMER M73 9.6	SPRING M59 9.6	AUTUMN M74 9.4		
SPRING M86 8.9	AUTUMN M77 8.9	SPRING M60 8.8	SPRING M63 8.6	SPRING M87 8.6	SPRING M95 9.7	SPRING M61 9.7	SPRING M97 9.9		
SPRING M85 9.1	SPRING M84 9.1	SPRING M105 9.3	SPRING M65 9.3	SPRING M96 9.3	SPRING M109 9.8	SPRING M99 9.9	SPRING M98 10.1		
AUTUMN M76 10.1	SPRING M89 9.8	SPRING M58 9.7	SPRING M88 9.6	SUMMER M72 9.3	SPRING M108 10	SUMMER M102 9.9	SPRING M91 10.2		
		MODERATE				HARD		VERY HARD	

BBC Sky at Night MAGAZINE

Equipment round-up

BEST OF 2023

Over the past 12 months, we've tested 28 separate pieces of astronomical kit. Here are five of the best...

ALL PHOTOS: @THESHED/PHOTOSTUDIO

Vaonis Vespera Observation Station

An all-in-one scope-plus-camera package

Vespera is an all-in-one astro-photography starter pack for urbanites. It is both a camera and a computerised Go-To telescope. A 2-inch (50mm) aperture refractor, its built-in optics offer 33x magnification and a 1.6° x 0.9° field of view. In place of an eyepiece is an on-board computer and Wi-Fi connection.

As a camera, Vespera takes image after image (every five to 10 seconds) to produce ever-better images – a process known as 'image stacking'. The entire workflow is automated and delivered in real time, with camera settings for thousands of deep-sky objects determined by an algorithm. All the user needs to do is download the Singularity app and choose from the database of recommended targets.

At any stage of the process a composite image of frames can be saved to a smartphone or tablet camera roll, or shared to social media. There is no branding on the images, with finished JPEGs saved in their native 1,920 x 1,080-pixel resolution. That's about two megapixels, technically making Vespera the lowest-resolution 'smart' telescope. It is also possible to export and share images as RAW files, and a new mosaic mode allows it to take multiple separate images and stitch them together.

Using Vespera is child's play. As well as its excellent Singularity app, it comes equipped with star pattern recognition software, and has auto-focus (unlike other smart telescopes). Although images lack sharpness and it doesn't take images of planets or good lunar shots, it can be used for solar observing, if paired with Vaonis's specialist solar filter.

What Vespera excels at is battling light pollution. With its optional light pollution filter, it is possible to get bright images of deep-sky objects that are impossible to see with the eye from light-polluted areas. Indeed, the Vespera is ideal for urban astronomers frustrated by lack of access to galaxies, nebulae and star clusters, with pockets deep enough to pay its premium price.

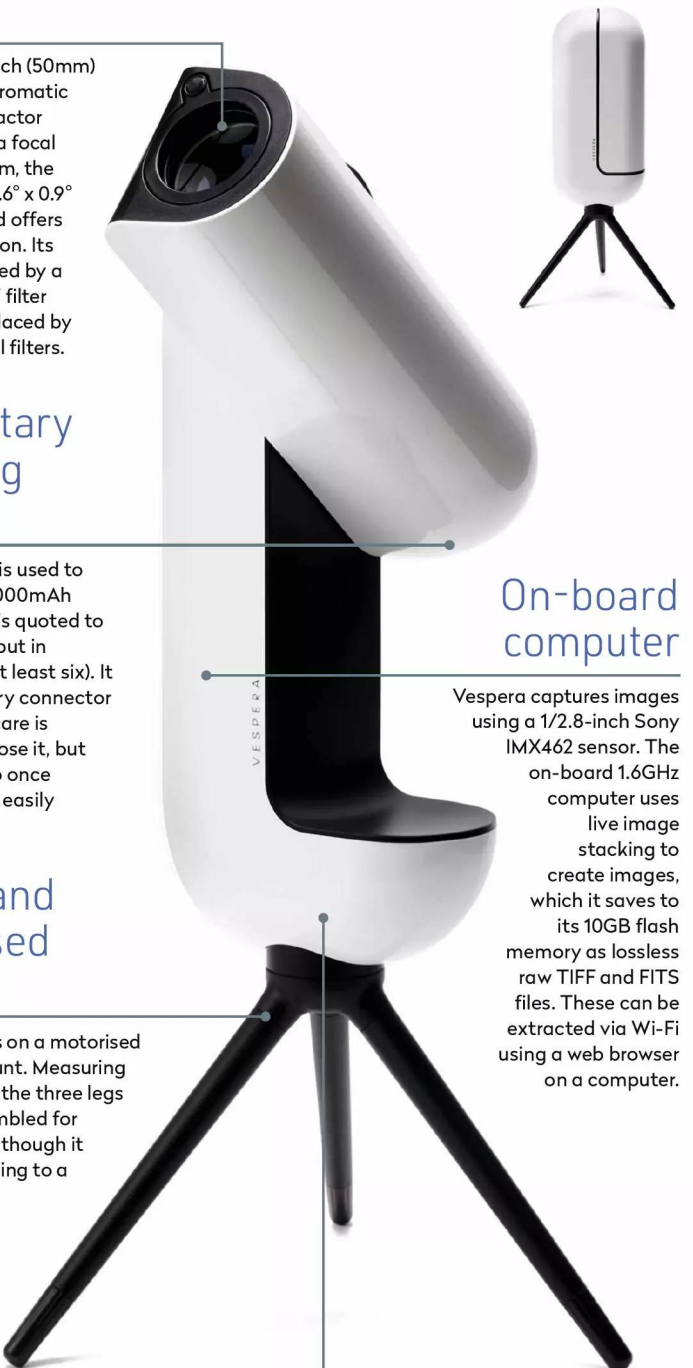
Vital statistics

- Price £1,300 (not incl shipping)
- Weight 5kg
- Sensor Sony Exmor IMX462 CMOS
- Supplier Vaonis
- Tel +33 4 84 98 00 21
- https://vaonis.com

Verdict ★★★★½

Optics

Featuring a 2-inch (50mm) aperture apochromatic quadruplet refractor telescope with a focal length of 200mm, the Vespera has a 1.6° x 0.9° field of view and offers 33x magnification. Its lens is surrounded by a plastic 'dummy' filter that can be replaced by various optional filters.



Proprietary charging cable

A USB-C cable is used to recharge the 7,000mAh battery (which is quoted to last four hours but in practice lasts at least six). It has a proprietary connector at one end, so care is needed not to lose it, but it's magnetic so once attached won't easily fall out.

On-board computer

Vespera captures images using a 1/2.8-inch Sony IMX462 sensor. The on-board 1.6GHz computer uses live image stacking to create images, which it saves to its 10GB flash memory as lossless raw TIFF and FITS files. These can be extracted via Wi-Fi using a web browser on a computer.

Tripod and motorised mount

Vespera swivels on a motorised altazimuth mount. Measuring just 20cm long, the three legs can be disassembled for easy transport, though it is worth upgrading to a full-size tripod.

Wi-Fi network

Vespera produces its own Wi-Fi network that up to five smartphones or tablets (iOS or Android operating systems) can connect to simultaneously. Each device must have the free Singularity app downloaded to see, save and share Vespera's latest images, though in our tests the Wi-Fi network stretched only around five metres.

Neck strap

The padded part of the neck strap can be unclipped, so it needn't get in the way when you mount the binoculars. The lens covers tether to the strap part that remains attached to the binoculars.

Waterproof and nitrogen-filled

The waterproofing prevents dew ingress which could result in fungal or algal growth, and the dry nitrogen filling means that there is no internal oxygen to cause oxidative corrosion.

Tethered lens caps

The objective lens caps and the rainguard-type eyepiece caps can be tethered to the binoculars' neck strap, so they are always to hand and unlikely to get mislaid. They fit very well so won't come off accidentally and expose your optics to damage.

Well-designed case

The lightly padded case has two internal pockets for storing a cleaning cloth, tripod adaptor and other accessories. It can be closed with a hook-and-loop fastening flap for convenience or a zip, and has both a shoulder strap and a belt/harness loop as carrying options.

Fully multi-coated

In order to get the full benefit of the light gathered by the 56mm-diameter objective lenses, as much of it as possible needs to be transferred to your eyes by the optical system. The dielectric, anti-reflective multi-coatings ensure that as much light as possible is transmitted by the lens surfaces.

Explore Scientific G400 15x56 roof prism binoculars

Satisfyingly sturdy, this pair fits the bill for moongazing and sharp, colourful stars

Small and light enough to be easily portable and held in the hands for short periods, but also with sufficient aperture and magnification to reveal more detail than popular hand-held binoculars like 10x50s, 15x56 binoculars occupy a special niche.

Explore Scientific's G400 15x56s are robust and compact, because they are hefty and have substantial untextured (but not slippery when dew-dampened) rubber armour. The smooth-operating hinge has a satisfying resistance to adjustment, preventing accidental resetting of the interpupillary distance.

The centre focus wheel is also silky-smooth in operation and has no backlash. It takes two complete turns of the wheel to get from 4.5m close focus to slightly beyond infinity focus at the other extreme. This means that the binoculars are very precise, which makes it easy to find the point at which the target object snaps into focus. The 'beyond infinity' focus enables people with mild short-sightedness to use the binoculars without glasses if they wish.

We found that the 16mm eye relief was just sufficient to enable us to see the full field of view when wearing glasses with the binoculars' eye-cups twisted fully down. The eye-cups also click into a definite half-way up position, and if you use this it will not easily slip. The focus wheel is at the eyepiece end of the hinge, so if you hold the binoculars by the objective end of the tubes, you will need to move a hand to refocus. This inconvenience will be unlikely to occur when you are using them for high-elevation targets, when it's better to hold them closer to the eyepiece end.

Binoculars like this are more effective when they are mounted. There is a threaded socket for a tripod adaptor at the end of the hinge. But you will need to choose a very narrow tripod adaptor, ideally the type that clips onto a captive pin in the socket.

Explore Scientific's G400 15x56 binoculars would suit someone who already has smaller hand-held binoculars but is looking for an additional, well-made, compact and robust pair for travel.

Vital statistics

- Price £329
- Aperture 56mm
- Magnification 15x
- Weight 1.1kg
- Supplier Telescope House
- Tel 01342 837098
- www.telescopehouse.com

Verdict ★★★★★

ALL PHOTOS: @THESHED/PHOTOSTUDIO

Sky-Watcher AZ-GTiX dual-saddle mount and tripod

A lightweight setup with double the mounting capacity

The AZ-GTiX is a lightweight, portable altaz mount that does away with the need to polar align. The package that we reviewed included the mount and tripod with extension pier, plus an L bracket for attaching either a camera or another telescope. This mount is a dual-saddle mount, one where you can have two telescopes or a combination of equipment on just one mount. Its load capacity accommodates one lightweight telescope up to 6kg on one saddle or up to 10kg total weight if using both saddles.

The mount has an integrated Wi-Fi adaptor to provide its own network so that you can control the mount via the downloadable SynScan app (suitable for iOS or Android), or you can attach an optional SynScan hand controller. For our tests we operated it via the app.

Power is provided either via an external power supply or by eight AA batteries. Despite a cold spell during our tests, the mount was still operational at the end of the review period – good news for anyone wishing to use this at a remote site.

The versatility of the AZ-GTiX mount with its dual saddles meant we could set it up either with a single telescope, single camera setup, camera and telescope, camera and camera with different lenses, or two telescopes. With the telescopes, we could use one for viewing and one for astrophotography. We also set it up during daytime for solar viewing with a hydrogen-alpha telescope on one saddle and a white-light telescope on the primary saddle – useful, for example, for public events around a solar eclipse.

Initial setup involved aiming the mount with our telescope level and pointing north, then powering up and connecting the SynScan Pro app via the mount's Wi-Fi network. In the settings, we ensured the app had fixed upon our location and then all that was needed was to perform a star alignment.

Overall, we were very impressed with this lightweight mount. We can highly recommend it.

Vital statistics

- Price **£399 mount head; £479 with tripod**
- Weight **Mount head 2kg; with tripod 5.2kg**
- Supplier **Optical Vision Ltd**
- Email **info@opticalvision.co.uk**
- www.**opticalvision.co.uk**

Verdict ★★★★★

Mount head

The mount head houses the electronics, Wi-Fi network adaptor, battery compartment housing eight AA batteries (not supplied), dual-axis Vixen-style adaptors, altitude clamp and azimuth knob. Compact and lightweight, it also features a bubble level to aid in setting up.

L bracket and additional mounting bracket

An L bracket with tripod knob for attaching a camera or a second telescope is supplied. For the latter, a Vixen-style adaptor is also provided. The Vixen attachment and extra adaptor can be adjusted to ensure alignment of the optics.

Ports

The mount head features a camera snap port for controlling a camera via the app, a port for an optional SynScan hand controller, an external power connector (7.5V–14V DC, 750mA) for an optional power tank, on/off switch and an integrated Wi-Fi adaptor for control via the SynScan app.

Altitude and azimuth adjustment

The altitude clutch wheel allows free movement and rotation about the altitude axis or is clamped to allow the drive to engage. The azimuth clutch knob does the same for the azimuth axis. Sky-Watcher's Freedom-Find auxiliary encoders ensure alignment when manually moving the mount head.

Tripod

Our package included a sturdy adjustable tripod with legs extendable to a maximum height of 139cm. The accessories tray easily slots into place, adding stability to the tripod. An extension pier gives added height to allow long-focal-length telescopes to steer clear of the tripod legs.

Integrated carrying handle

The robust carrying handle is specially machined to allow the fitting of a guidescope bracket, an essential accessory for many astrophotographers. It also makes mounting and balancing the telescope easy and secure, as it reduces the risk of dropping the telescope while transporting or adjusting its position.

Retractable dew shield

A dew shield is essential to ensuring optics stay free from the effects of moisture. The fully retractable dew shield ensures the system is compact, making the refractor only 482mm when pushed back, and reduces the risk of damaging the telescope while moving it.

Vixen-style dovetail and built-in tube ring

The 300mm Vixen-style dovetail plate is smartly colour-coordinated and designed to be easily attached to standard equatorial mounts. The accompanying clamshell-style tube ring holds the Z4 securely with no flexure, and its position along the dovetail plate is easily adjustable to ensure the setup can be properly balanced.

Dual-speed focuser

The large 3.4-inch focuser reduces vignetting and comes with a 1:10 fine adjustment knob for greater control and accuracy. The 360° built-in rotator allows complete rotation of the focuser barrel, ensuring no loss of focus while adjusting camera angle or orientation.

Adaptors

The suite of adaptors (M86, M68, M54 and M48) enable attachment to all types of cameras and accessories for DSLRs and CMOS or CCD cameras. The M48 adaptor has an internal thread for two-inch filters.

Sharpstar Z4 sextuplet apo astrograph

Designed for APS-C cameras, this six-lens scope delivers on its flat-field promises

The Sharpstar Z4 is the latest from the Sharpstar family of astrograph refractors geared towards astrophotography. With a 100mm front element, it is second in size only to the Sharpstar 140PH. While its sibling boasts greater aperture and focal length, the Z4 arguably packs a punch with a six-element optical system. This sextuplet design means the Z4 goes above and beyond conventional doublet and triplet apochromatic refractors, by further minimising image distortions including vignetting, field curvature and colour fringing.

Mounting the Z4 was easy enough, the carrying handle enabling us to lift it into position, but we did note that the extra glass incorporated into the sextuplet design added considerable weight. At 4.3kg, it pushes close to the limits of what we would deem a portable or a beginner's telescope, especially if adding a large camera and guide accessories. While we were able to achieve balance relatively easily for our imaging setup, we did wonder whether the Z4 would benefit from a slightly longer dovetail for those with heavier imaging equipment. Nevertheless, we found preparing the Z4 for clear skies a breeze.

Attaching the camera was relatively easy thanks to the adaptors provided, although we needed our own M48 to T2 adaptor to attach the DSLR via a T-ring. Sharpstar recommends using a crop sensor (APS-C) camera on the Z4, and so we popped our Canon 70D on first. The rack and pinion focuser felt exceptionally well-made, and allowed complete control over the focusing process.

Some initial test frames confirmed a wonderfully flat field of view with no observable star curvature or halos, despite the prominent star Gamma Cygni.

Stretching the data in post-processing confirmed a flat field with pin-sharp stars edge to edge. We could not detect any fringing around the stars either.

Price-wise, the Z4 is positioned towards established astrophotographers rather than beginners, though it is certainly user-friendly enough to be suitable for any and all imagers, as long as they use APS-C DSLR cameras. Ultimately, the Z4 proved a superbly-made and smart astrograph that contributed to beautifully clean images.

Vital statistics

- Price **£2,259**
- Aperture **100mm**
- Focal length **550mm, f/5.5**
- Weight **4.3kg**
- Supplier **First Light Optics**
- Email **questions@firstlightoptics.com**
- www.**firstlightoptics.com**

Verdict ★★★★★

ALL PHOTOS: @THESHED/PHOTOSTUDIO

Altair Astro Hypercam 533M mono camera

Making the move to mono? This superior sub-£1,000 camera could tempt you

The Hypercam 533M is an interesting addition to the Altair Astro family of astronomy cameras, with a medium-sized sensor that allows for a cooled, high-performance unit in an affordable price range. The model we received for review was the mono version, a colour model also being available, but we matched the mono camera to our filter wheel to use our colour and narrowband filters. We used 2-inch filters, but 1.25-inch filters could also be suitable without causing vignetting, depending on the spacing and telescope involved. It would be prudent to take advice from your dealer when considering filter choices.

Nicely machined and finished, the build quality is excellent. The thread on the front is a standard M42 x 0.75mm and can be used with the supplied nosepiece or, as we did, attached directly to our filter wheel, allowing for the 17.5mm spacing between the front flange of the camera and the imaging sensor.

Right from the start, our experience with this camera was very positive. After downloading the driver package and the latest version of the AltairCapture app, we powered up the camera and plugged it into our laptop with the included 1.5-metre USB 3.0 cable. After selecting the 533M as our camera, we configured the thermo-electric cooling to our desired target of –5°C, then set the resolution to 14-bit and we were good to go; live images started rolling in. On our system we achieved frame rates of 13.2 frames per second (fps), which rose to 25.5fps with a 'Region of interest' area set at 25 per cent of the full sensor size.

When targeting galaxies and globular clusters, the 533M gave very clean, low-noise images.

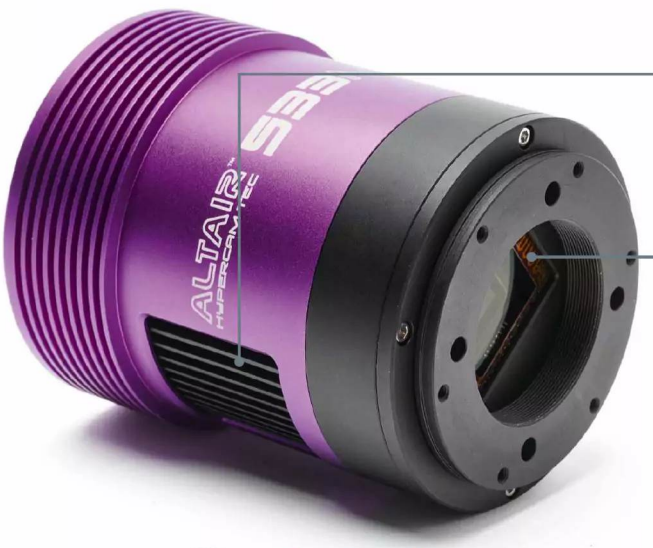
The sensitivity performance of the CMOS sensor in the 533M can be increased with the gain setting. When observatory time is at a premium, the ability to use the 533M to take more photographs of the actual target is always a bonus.

Overall, this easy-to-use astro camera gives rewarding results and is a good investment for monochrome imaging.

Vital statistics

- Price £999
- Weight 630g
- Extras Carry case, 12V DC power supply, software
- Supplier Altair Astro
- Email info@altairastro.com
- www.altairastro.com

Verdict ★★★★★



Two-stage cooling

To reduce noise, the imaging sensor can be cooled down to 40°C below ambient thanks to its software-controlled cooling ability, a large heat sink and powerful, but quiet, fan.

Heated optical window

The Hypercam 533M carries a two-year 'frost-free' guarantee for the sensor. There is also a software-controlled heating element around the outside of the anti-reflection window which can be turned on if dew becomes a problem.

Software

A one-year licence for SharpCap Pro is provided free of charge, along with the app AltairCapture, which provides full camera control, allows capture of both single FITs images and AVI files, and operates the cooling, window heating and gain settings.

Protective case

A sturdy padded ABS-style carry case is supplied with the camera to ensure safe transportation and storage. Along with the camera, there is room for a 2-inch nosepiece and cap, software CD, additional desiccant tube and the body of the 12V power supply that comes with the package.

USB 3.0 with USB 2.0 hub

The camera must be operated via a high-quality USB 3.0 lead no more than two metres in length. There are two USB 2.0 sockets which allow for low-bandwidth items like an auto-focuser or filter wheel to be controlled via short leads.

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DISCOVER
More great night sky events in *BBC Sky at Night Magazine*'s Sky Guide each month

The night sky month by month 2024

Astronomy expert **Pete Lawrence** presents *The Sky at Night* on BBC Four and writes *BBC Sky at Night Magazine*'s monthly Sky Guide

Your guide to the stars throughout the year
by **Pete Lawrence**

36 January
Double Jovian shadow transit

40 February
Comet 62P Tsuchinshan 1

46 March
Comet across Coathanger Cluster

50 April
Partial solar eclipse

54 May
Eta Aquariid meteor shower

60 June
Clair-obscur effects on the Moon

64 July
Noctilucent cloud displays

68 August
Perseid meteor shower

74 September
Perigee Harvest full Moon

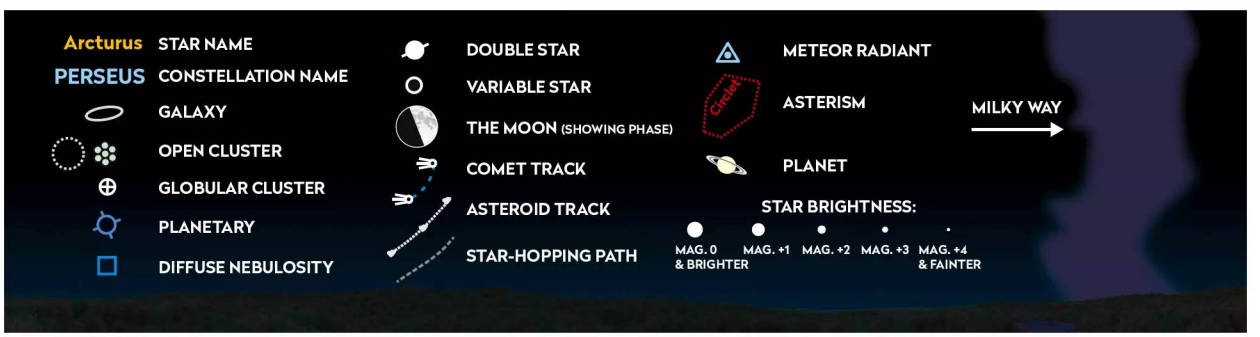
78 October
Ganymede shadow transit

82 November
Rare transit of Titan's shadow

88 December
Ganymede shadow transit

Key to monthly star charts

Use this key to get the most out of each month's detailed star chart



January

Don't miss the Quadrantid meteor shower peak and Comet 144P/Kushida

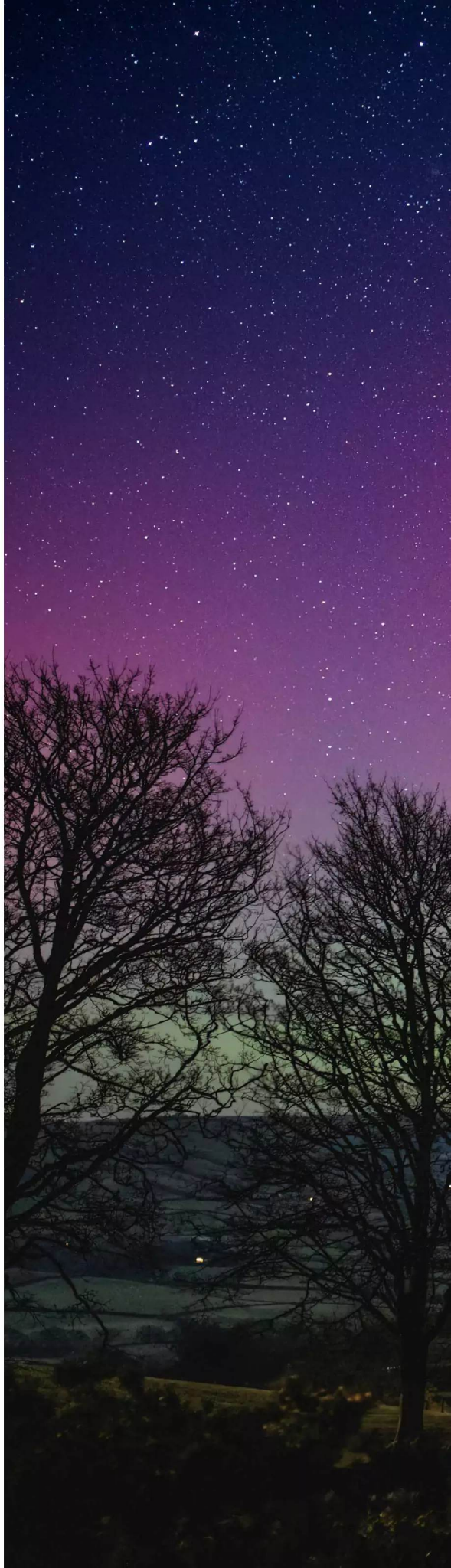
1 January Comet 144P/Kushida lies 2° south of Uranus

4 January Quadrantid meteor shower peak (am)

7 January Double shadow transit of Jupiter, from 02:09 UT until setting

18 January Jupiter lies 2° south of first quarter Moon (pm)

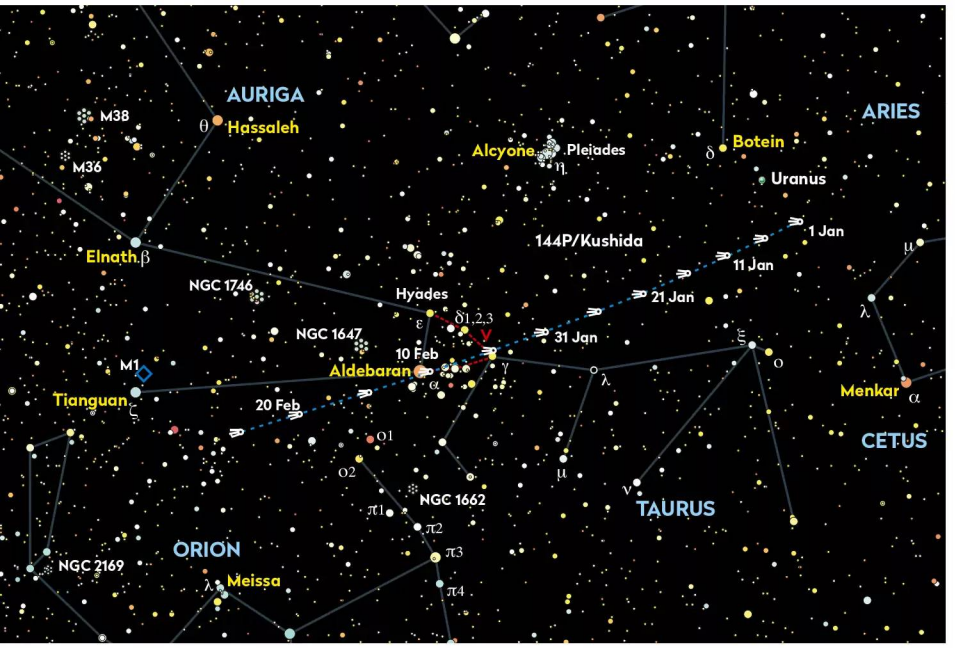
22 January Jewelled Handle clair-obscur visible on the Moon (am)



Aurora ▷

Karl McCarthy, Mynydd Illtud, Brecon Beacons, 26 February 2023

January at a glance



▲ Comet 144P/Kushida passes through Taurus during January and February

▼ The last quarter Moon will interfere with the Quadrantid meteor shower peak

The planets put on a poor show at the start of 2024. In January, we find **Jupiter** and **Uranus** holding the fort, the others battling the evening and morning twilight.

Comets provide a few offerings for small telescope, including **62P/Tsuchinshan 1**, **C/2021 S3 PanSTARRS**, **12P/Pons-Brooks**, **103P/Hartley 2** and **144P/Kushida**, all predicted brighter than 10th magnitude. 144P/Kushida is especially well placed for Northern Hemisphere observers. On 1 January it's about 2° south of Uranus, crossing from Aries into Taurus during January, ending the month west of the Hyades.

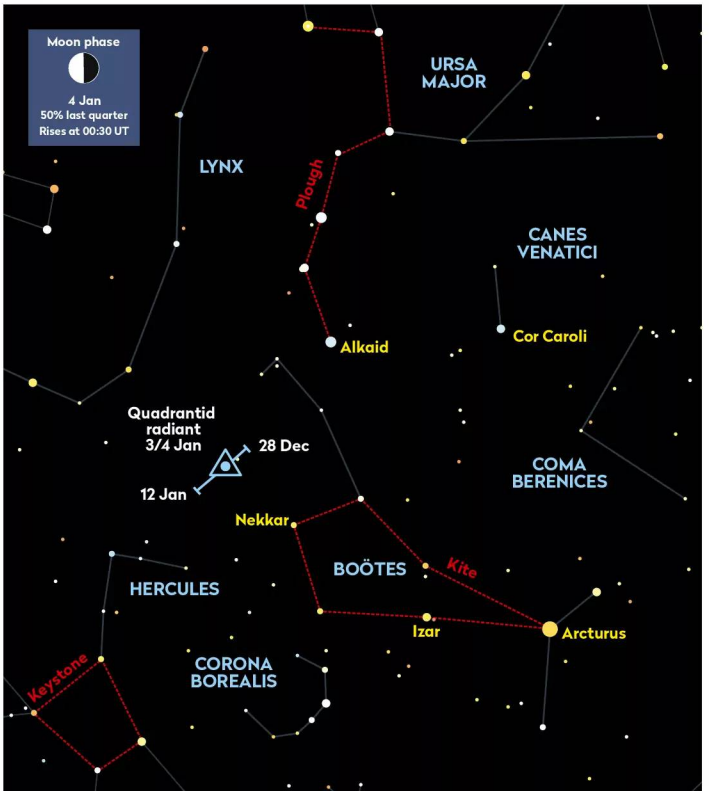
The Moon's fuller phases ride high in the January night, drowning out all but the brightest of winter stars. Full Moon occurs on 25 January, new on 11 January, the best time for stargazing. The Moon will influence the build up to the peak of this year's **Quadrantid meteor shower**, but carefully placing the last quarter Moon behind a fence or building may give you a decent display of this rich shower. The narrow Quadrantid peak is expected around 10:00 UT on 4 January, so it's the period up to dawn on 4 January which is optimal.

When the Moon isn't visible, the stars of winter shine bright, led by **Orion, the Hunter**. The three Belt stars in a straight line mark the centre of Orion's body. His 'shoulders' are marked by bright Betelgeuse (Alpha (α) Orionis) to the northeast and Bellatrix (Gamma (γ) Orionis) to the northwest. In the southwest there's blue supergiant Rigel (Beta (β) Orionis) with Saiph (Kappa (κ) Orionis) in the southeast corner.

Hanging south from Orion's Belt is his sword, a faint line formed by stars and deep sky objects. Look at the sword through binoculars or a telescope and you'll be rewarded by the superb **Orion Nebula**, M42, a luminous emission nebula powered by the radiation from young stars at its heart in the Trapezium Cluster. But M42 isn't the only jewel in Orion. The sword is formed from M42, with smaller **M43** next to it, NGC 1977 the **Running Man Nebula**, clusters **NGC 1980** and **NGC 1981**, and a smattering of other stars and nebulous regions.

Orion's Belt is part of the large open cluster **Collinder 70**. Look at it with binoculars and many additional cluster members can be seen. The Hunter's head is another deep sky object. Marked by the star Meissa (Lambda (λ) Orionis), look at the region using binoculars or a small telescope to view the 'L' shaped pattern of the head stars, which sit at the centre of open cluster **Collinder 69**.

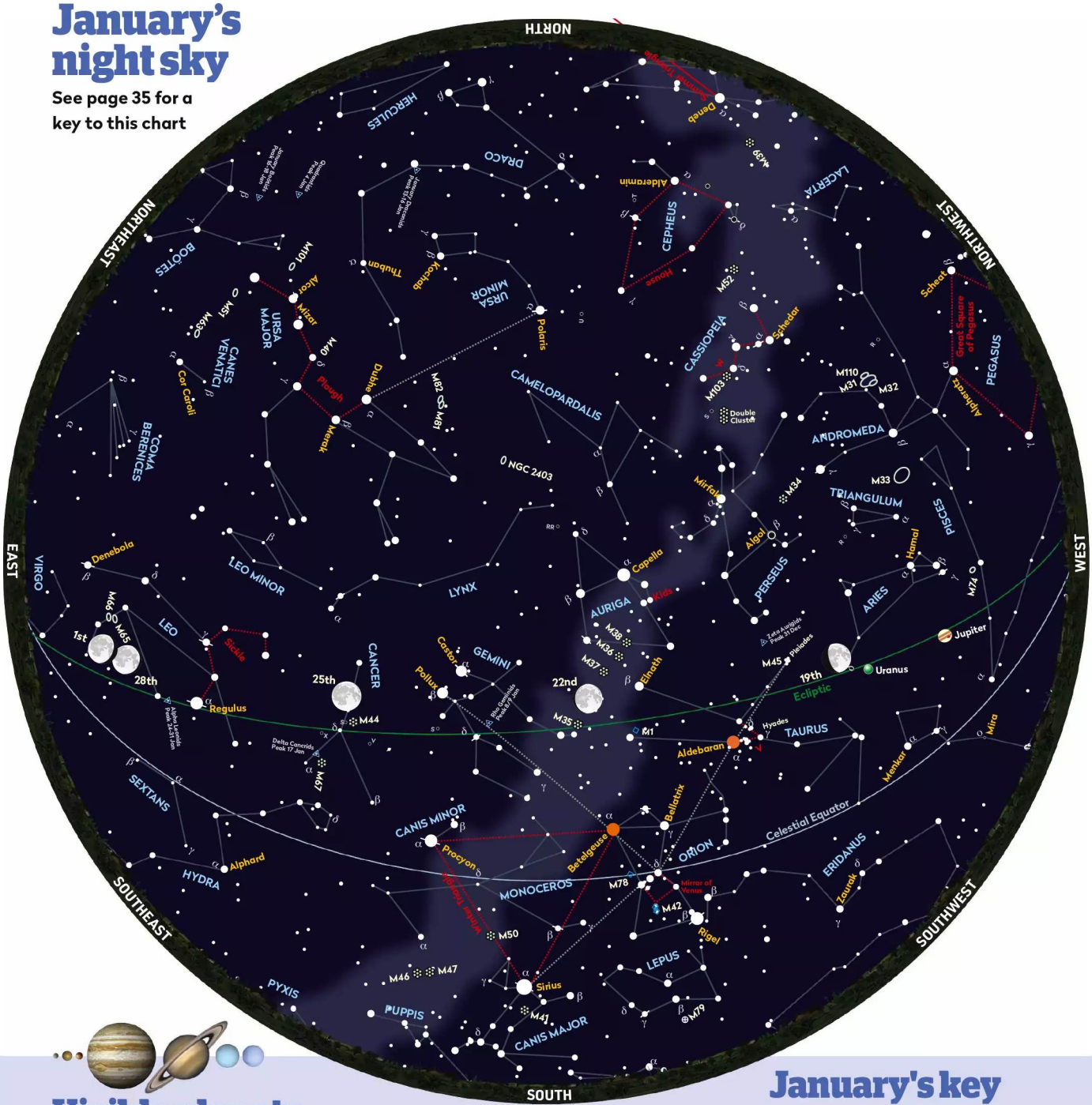
Orion also contains reflection nebula **M78** and the emission nebula NGC 2024 known as the **Flame Nebula**, near the eastern Belt star Alnitak (Zeta (ζ) Orionis). The faint **Horsehead Nebula** B33 lies south of Alnitak, a finger of dark material silhouetted in front of the emission curtain IC 434. A long, tracked exposure of Orion may reveal a giant, glowing emission ring known as **Barnard's Loop**, together with the smaller, round **Angelfish Nebula** which surrounds Collinder 69. Orion is south around 23:00 UT on 1 January, 22:00 UT mid-month and 21:00 UT on 31 January.



PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

January's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Morning planet, best early January. Close encounter with Mars on 27 January.

Venus
Morning planet, slips closer to the Sun this month.

Mars
Morning planet, hard to see well. Near Mercury on 27 January.

Jupiter
Evening planet edging into twilight by the end of January.

Saturn
The Ringed Planet loses ground to the evening twilight during January.

Uranus
This ice giant planet is currently well placed in the evening sky.

Neptune
The position of this planet deteriorates in the evening sky over the month.

January's key Moon phases

LAST QUARTER
4 Jan

NEW MOON
11 Jan

FIRST QUARTER
18 Jan

FULL MOON
25 Jan

February

Look out for the many lunar spectacles on display, and Comet 62P/Tsuchinshan

7 February Dark skies for comet 62P/Tsuchinshan

14 & 15 February Waxing crescent Moon near Jupiter (pm)

16 February First quarter Moon south of the Pleiades (pm)

17 February Lunar X and V optimal to view around 00:40 UT

22 February Venus and Mars lie 38-arcminutes apart (dawn)

◁ **Mars occultation trails**

Tomáš Slovinský, Kosice, Slovakia, 8 December 2022

February at a glance

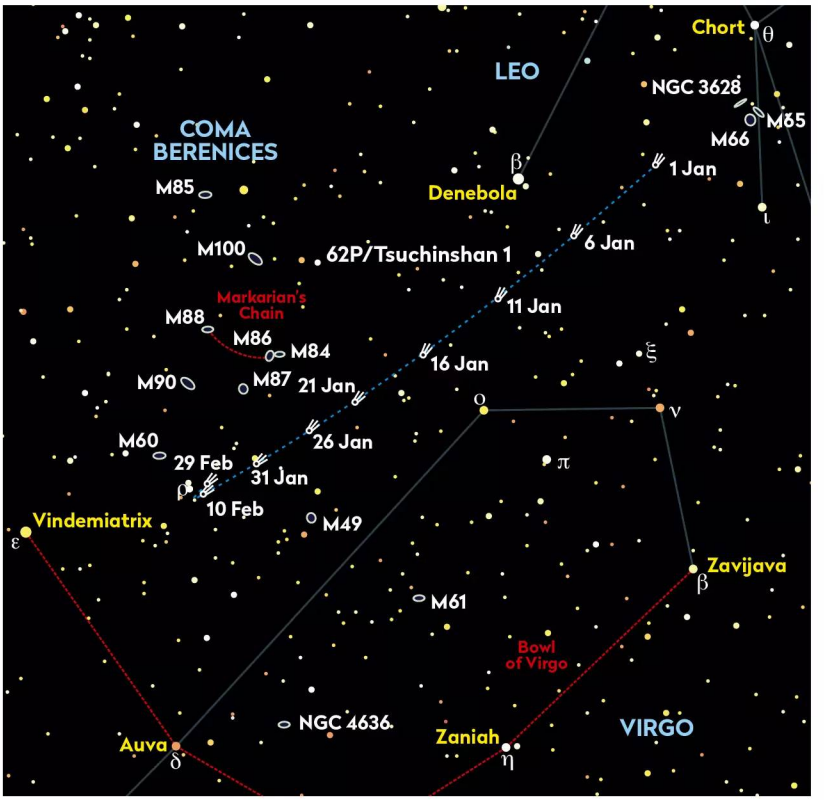
2024 is a leap year, meaning February contains an extra day. This corrective action 'mops up' the accumulated error caused by Earth's orbit being 365.2564 days long. The extra quarter-day is ignored for three out of every four years, the fourth year's leap day cancelling the cumulative offset.

Apart from **Jupiter** and **Uranus**, the planets remain poor, generally too close to the Sun to be seen against its glare. But some of the Moon's passes next to bright planets are impressive. On 1 February it's a star which gets the treatment, **Spica** (Alpha (α) Virginis) appearing just 1° from the centre of a 65%-lit waning gibbous Moon at dawn.

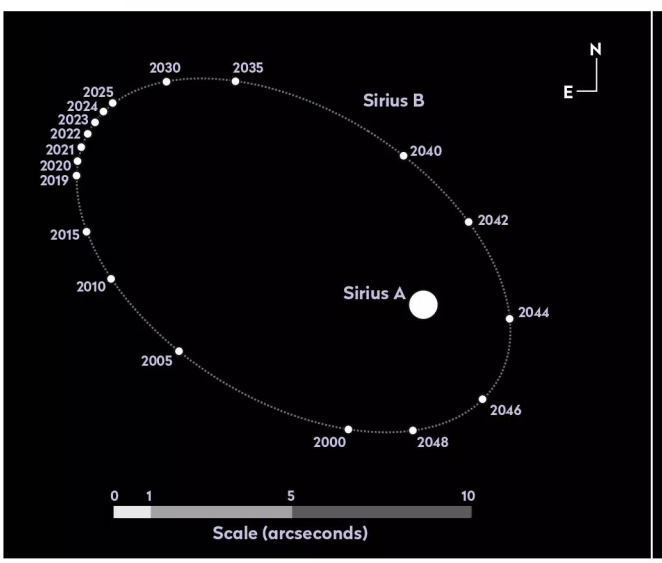
On 7 February, a 10%-lit **waning crescent Moon** sits 9.3° southwest of brilliant Venus in the dawn twilight, the altitude of both objects, especially the Moon, low. The Moon's pass of Jupiter and Uranus on the evenings of 14 and 15 February is better placed. On 14 February after darkness falls, a 29%-lit waxing crescent Moon sits 7.2° west of mag. –2.1 Jupiter, with the gap decreasing to 5° just before midnight.

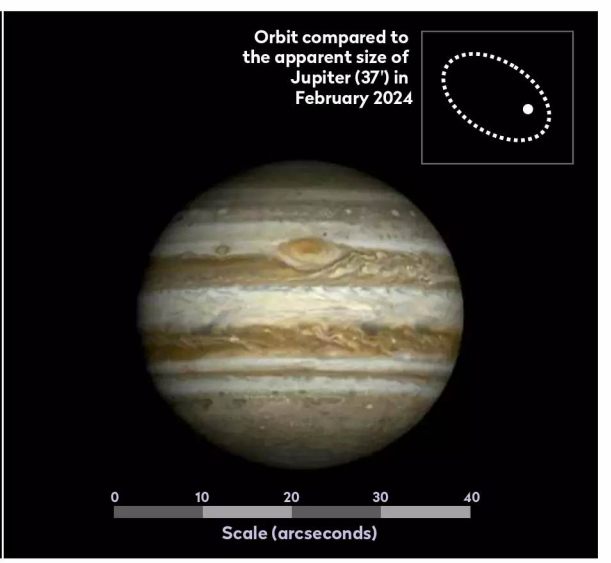
As darkness falls on the following evening, the now 40%-lit waxing crescent Moon sits 7.2° northeast of Jupiter and 4.2° west-northwest of mag. +5.8 Uranus. The Moon's eastward motion takes it to 2.4° of Uranus, as measured from the Moon's centre just before both set around 01:30 UT on 16 February. Later that evening, using binoculars, place the now first quarter Moon (50%-lit) at the bottom of your field of view and you'll see **the Pleiades** above it.

Orion, the Hunter remains prominent in the February night sky, its pattern useful for navigating. Follow Orion's Belt southeast (down and left from the UK) and you'll arrive at the brightest night star, **Sirius** (Alpha (α) Canis Majoris). This dazzling beacon is the alpha star of Canis Major, the Great Dog, and is often referred to as the **Dog Star**. It has a white dwarf companion, known as the **Pup Star** (Sirius B), which has a mutual 50-year orbit with Sirius A, the name given to the bright component visible to the naked eye.



▲ Path of comet 62P/Tsuchinshan 1 as it tracks from Leo through into Virgo



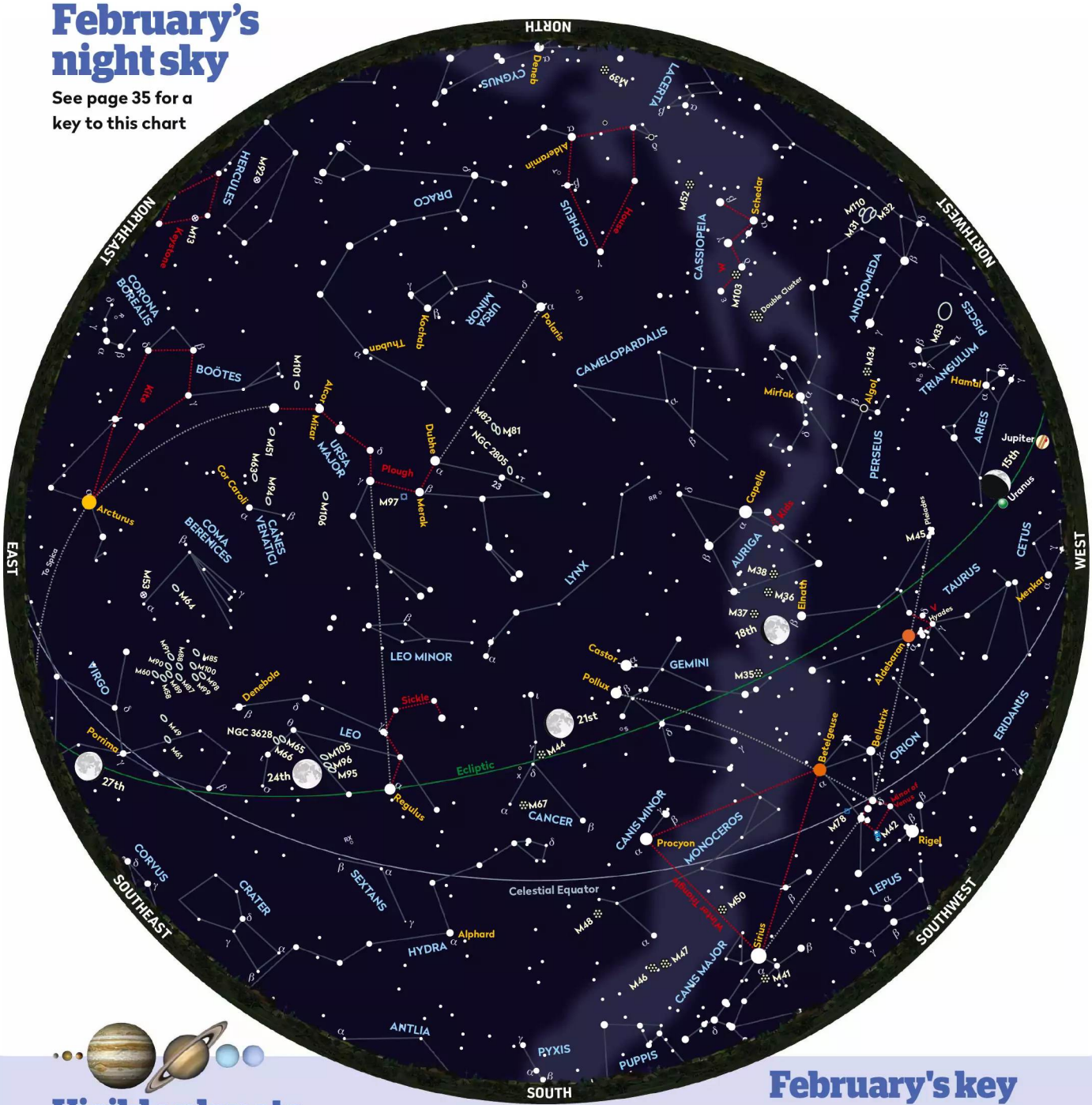


▼ The orbit of Sirius B has both stars optimally separated

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

February's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Unlikely to be seen, superior conjunction on 28 February.

Venus
Morning planet, visibility deteriorating as it approaches the Sun.

Mars
Too low and dim to be seen properly in the morning sky this month.

Jupiter
Evening planet, best placed at start of month when still at decent altitude. Position deteriorates through month.

Saturn
Not viable this month, solar conjunction on 28 February.

Uranus
Evening planet, losing altitude as darkness falls. Currently Ccose to Jupiter.

Neptune
Lost in the evening twilight at the end of the month.

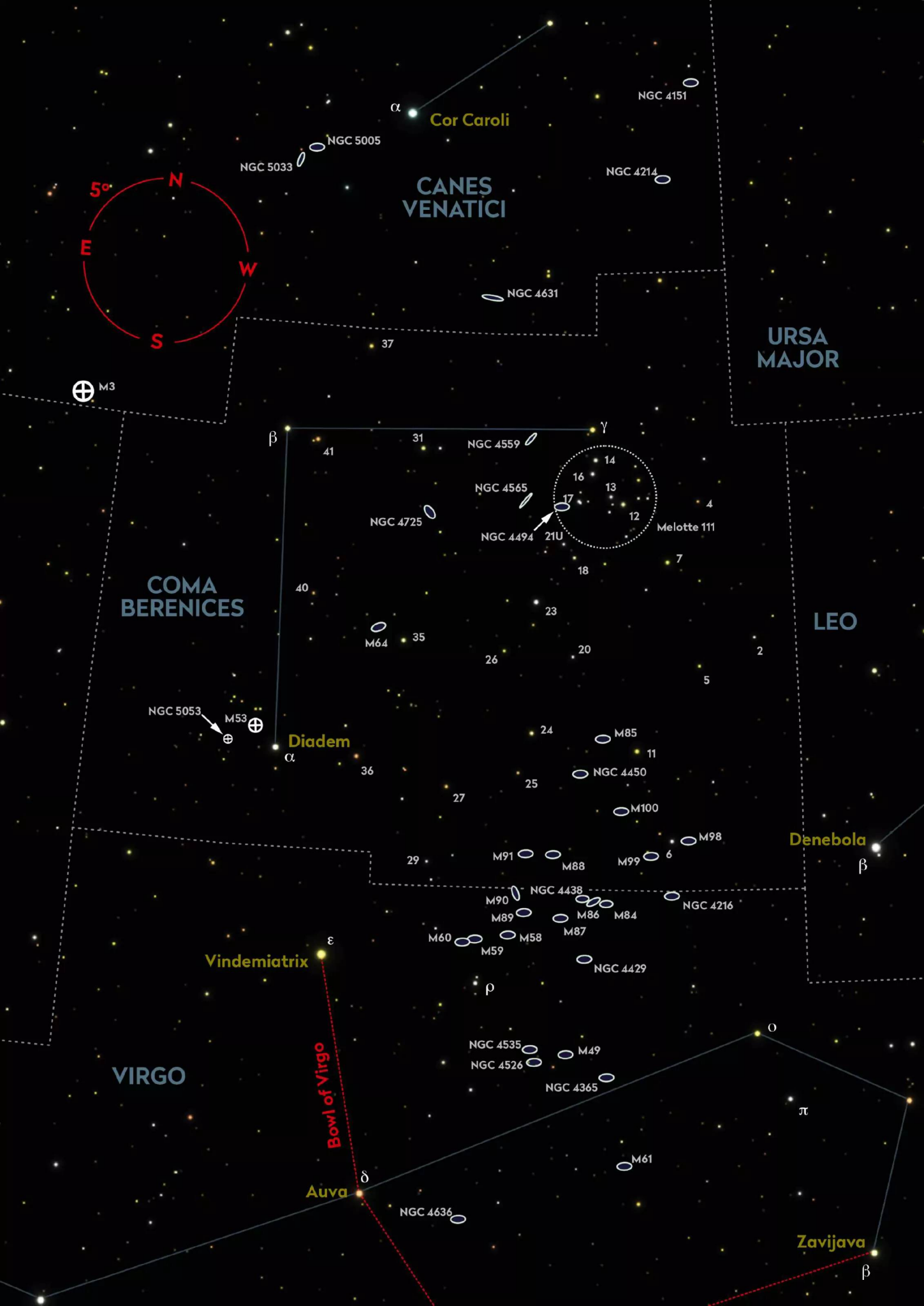
February's key Moon phases

LAST QUARTER
2 Feb

NEW MOON
9 Feb

FIRST QUARTER
16 Jan

FULL MOON
24 Jan


α
Cor Caroli
NGC 4151
NGC 5005
NGC 5033
NGC 4214
CANES VENATICI
5°
N
E
W
S
NGC 4631
37
URSA MAJOR
M3
β
γ
31
41
NGC 4559
14
16
13
NGC 4565
17
4
12
NGC 4725
NGC 4494
21U
Melotte 111
7
18
COMA BERENICES
40
23
LEO
M64
35
26
20
2
5
NGC 5053
M53
Diadem
α
24
M85
11
36
NGC 4450
25
27
M100
M98
Denebola
β
29
M91
M88
M99
6
NGC 4438
M90
M89
M86
M84
NGC 4216
M87
M60
M58
M59
ε
Vindemiatrix
NGC 4429
ρ
o
NGC 4535
M49
NGC 4526
VIRGO
Bowl of Virgo
NGC 4365
π
M61
δ
Auva
NGC 4636
Zavijava
β

Constellation of the season

SPRING: Coma Berenices

Coma Berenices, shortened to Coma, is an ancient constellation located between Canes Venatici to the north and Virgo to the south. It is flanked by Boötes, the Herdsman to the east and Leo, the Lion to the west. It's the 42nd largest constellation by area, placing it about half way down the list of 88 constellations.

Coma Berenices represents the hair of Queen Berenice II of Egypt, consort to ruler Ptolemy III Euergetes. She vowed to cut off her hair as a sacrifice to the gods in exchange for the safe return of Ptolemy from battle. As legend has it, the hair was placed in the heavens as the constellation we see today.

Coma isn't bright, containing just three Bayer lettered stars; mag. +4.3 Diadem (Alpha (α) Comae Berenices), mag. +4.2 Beta (β) and +4.3 Gamma (γ) Comae Berenices. These form an approximate right-angled triangle, with Beta in the northeast marking the right-angle. However, Coma is full of interest. Its most striking feature becomes apparent under a dark, moonless night when the star cluster Melotte 111 appears as a shimmering triangular mass of stars cascading south from Gamma Comae and at the edge of naked eye visibility. The cluster occupies an area roughly 8° high by 8° wide. It contains around 40 stars down to mag. +10.0 and is approximately 280 lightyears distant. Melotte 111 is also known as Collinder 256 and as the Coma Star Cluster.

▼ Left: The Needle Galaxy, NGC 4565, appears as a thin streak of light through the eyepiece

Right: Messier 53 is a fine globular cluster located near Diadem (Alpha (α) Comae)

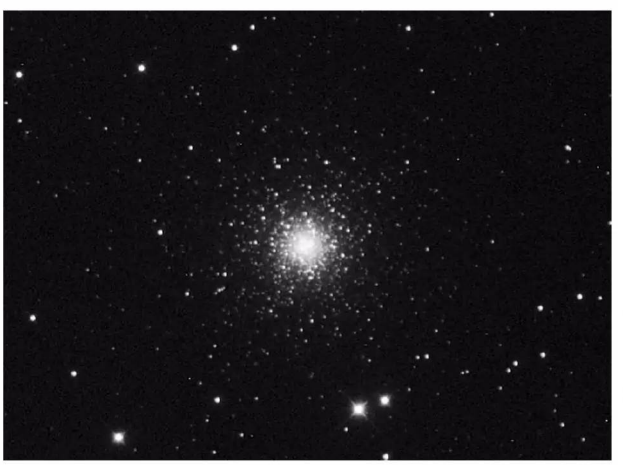
Triple system

If you imagine Alpha, Beta and Gamma Comae representing three corners of a square, mag. +5.5 24 Comae marks the fourth corner. It's a beautiful colour contrast double; an orange mag. +5.0 primary with a mag. +6.6 blue secondary, which is also a spectroscopic binary – hence 24 Comae is actually a triple system.

Despite its relatively small and dim status, Coma Berenices contains a decent number of impressive deep sky objects. Aside from Melotte 111, Coma is galaxy territory, marking the direction towards the Coma Supercluster, which contains the Coma and Leo Clusters of galaxies. The northern part of the Virgo Cluster of galaxies also overlaps part of Coma Berenices and here you'll find six Messier galaxies; M85, M88, M91, M98, M99 and M100, all nestled into the southern part of Coma.

Other galaxies visible in Coma are ninth magnitude M64, 0.9° northeast of mag. +4.9 35 Comae. This is known as the Black Eye Galaxy, a name it gets because it's a spiral galaxy which appears elliptical through the eyepiece and is crossed by a high contrast, dark dust lane, giving it the appearance of having a shiner. Further north and closer to Gamma Comae is a smattering of galaxies of different shapes and sizes. Here you'll find the impressively narrow streak of the mag. +9.6 Needle Galaxy, NGC 4565. This is an edge-on spiral which looks like a narrow needle of light through the eyepiece. These are just several of many galaxies in the constellation and it's well worth trying to see as many as you can.

As well as galaxies, Coma is known for two globular clusters which lie in close apparent proximity to one another. The brightest is M53, a rich globular 13 arcminutes across with an integrated magnitude of +7.6. It sits a fraction under 1° northeast of Diadem. A similar distance to the southeast of M53, or alternatively 1.5° east of Diadem, lies the mag. +9.8 globular NGC 5053, a far more diffuse object than M53.



ALL PICTURES: PETE LAWRENCE

March

Don't miss comet C/2021 S3 PanSTARRS crossing in front of the Coathanger Cluster

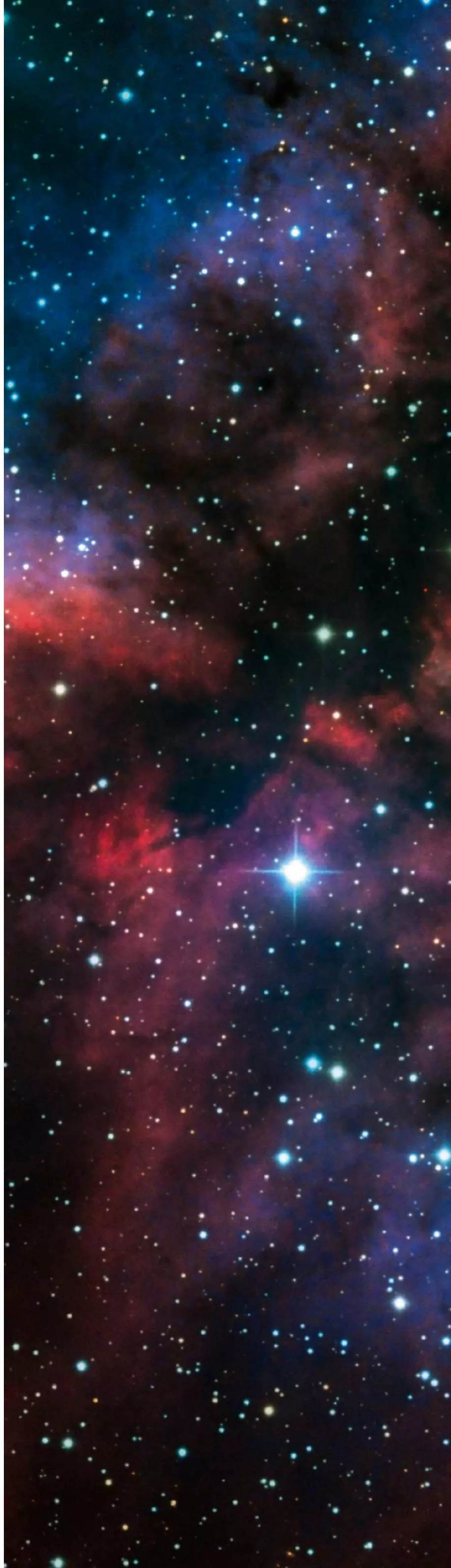
2 March Minor planet 3 Juno reaches opposition

13 March Jupiter lies near a waxing crescent Moon (pm)

14 March Waxing crescent Moon lies near the Pleiades (pm)

26 March Spica lies very close to the Moon (pm)

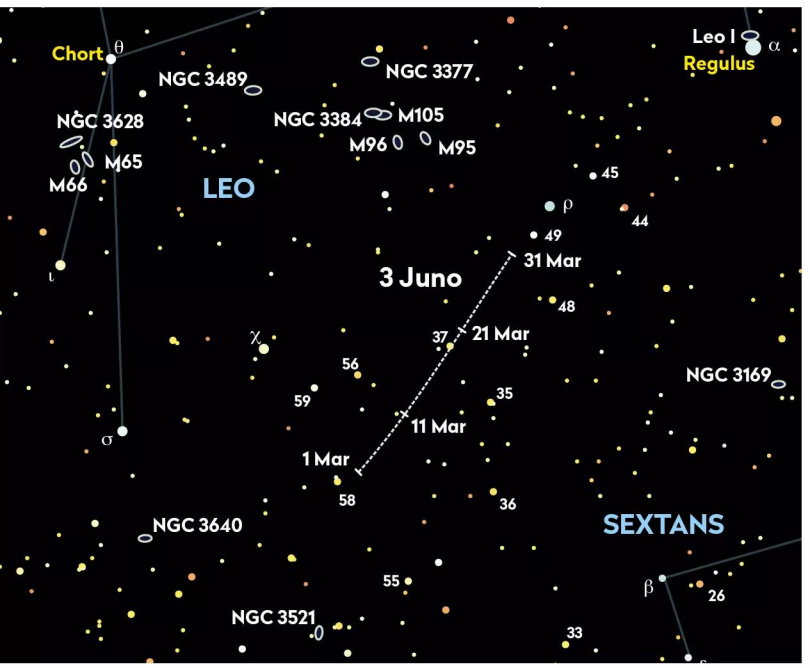
29-31 March C/2021 S3 PanSTARRS crosses the Coathanger Cluster



The Skull and Crossbones Nebula, NGC 2467 ▷

Sean Liang, remotely via El Sauce Observatory, Chile, February 2021 to November 2022

March at a glance



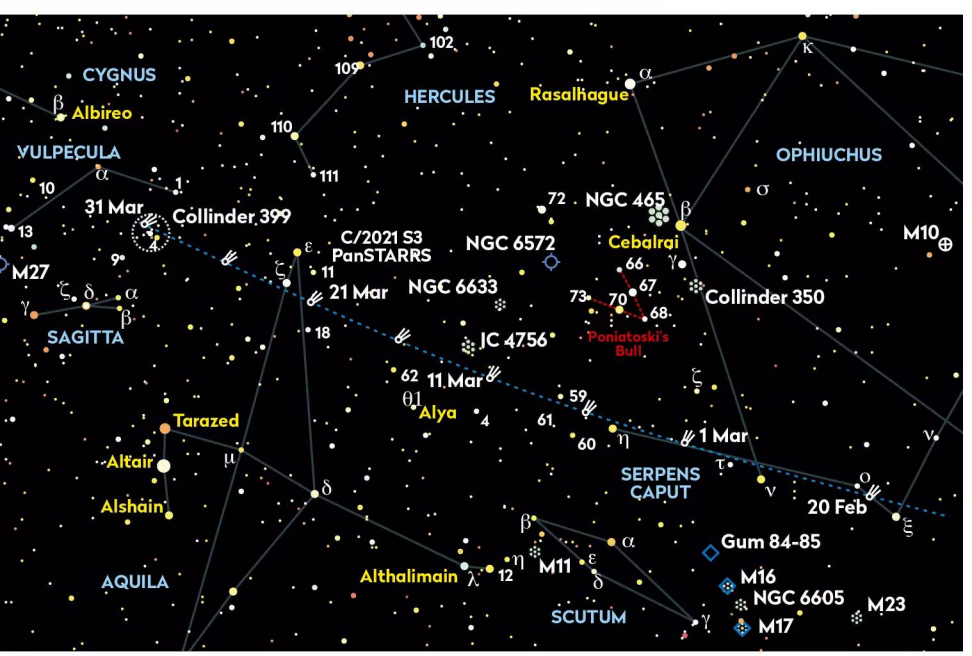
▲ Minor planet Juno reaches opposition on 2 March, appearing among the stars of southern Leo

▼ At the end of March, C/2021 S3 PanSTARRS passes in front of Collinder 399

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

The Northern Hemisphere's spring, or vernal, equinox occurs on 20 March, marking the transition of the Sun's northward movement across the celestial equator.

Jupiter and Uranus struggle this month as the evening twilight expands to envelop them. Coupled with a shallow ecliptic angle in the morning sky, this is a poor month for the main planets. Not so minor planet **3 Juno** which reaches opposition on 2 March, shining around ninth magnitude in the southern part of **Leo, the Lion**.



Comets remain interesting during March, with **C/2021 S3 PanSTARRS** moving into a more favourable position and shining bright enough to be seen with binoculars. Both **62P/Tsuchinshan 1** and **144P/Kushida** are expected to be brighter than 10th magnitude, and comet **C/2023 A3 Tsuchinshan-ATLAS** is predicted to brighten from 13th to 12th magnitude.

When the Moon is full and near perigee, the point in its orbit closest to Earth, great fuss is made of what's been coined a '**Supermoon**' in popular culture. A fortnight later, the 25 March full Moon is close to lunar apogee which occurs on 23 March, the point when the Moon is furthest from Earth. This has an unofficial name too, known as a '**Micromoon**'. The Moon will be undergoing a weak penumbral eclipse on the morning of 25 March from 04:53 UT until moonset.

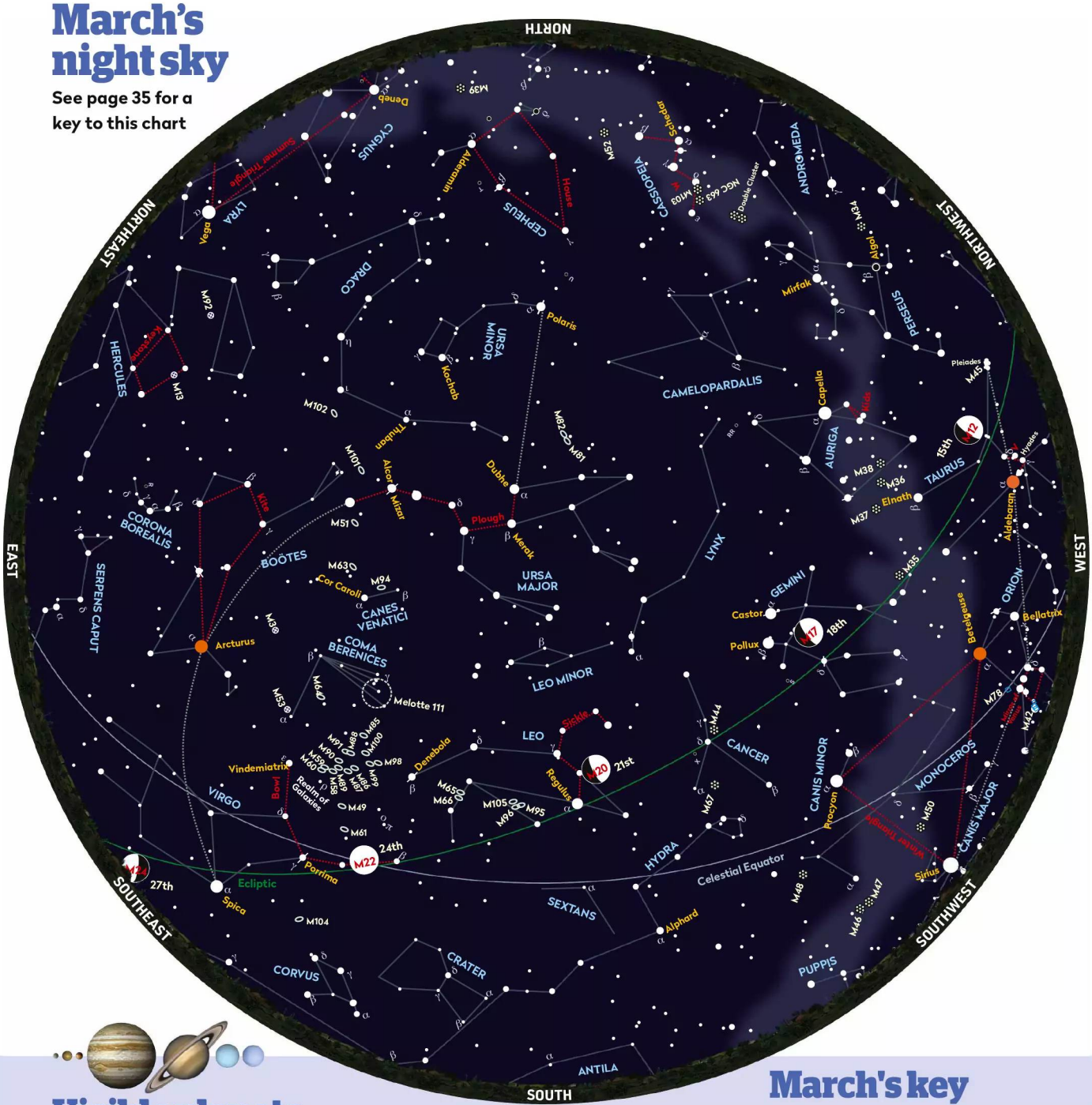
Orion, the Hunter struggles to hang on throughout March, its westward drift dragging the Hunter towards the expanding evening twilight. Draw a line from Rigel through Betelgeuse and keep it going for almost twice that distance to arrive at **Castor and Pollux**, **Alpha (α) and Beta (β) Geminorum**. These represent the heads of the Twins of Gemini. Castor is interesting as it's a sextuplet star system: six stars in mutual orbit. Through a telescope under 200x or higher magnification, the main components appear as two white stars of mag. +1.9 and +2.9, separated by 4.4-arcseconds.

Almost overhead early evening you'll find the easy to recognise **Plough** or Saucepan asterism. Identify the pan and extend the line of the side nearest the handle down and away from the handle. Eventually, you'll arrive at bright **Regulus** (Alpha (α) Leonis) in Leo, the Lion, easy to confirm as this star sits at the southern end of a backward question mark pattern, known as **the Sickle**.

Draw a line from Regulus to the northern Twin star Castor and, using binoculars, look at the position slightly south of the mid-point of this line. Here you'll find the fantastic sight of M44, the **Beehive Cluster**, in the heart of Cancer, the Crab. The Crab appears as a faint, inverted 'Y'. Locate the star marking the southeast point of this pattern, Acubens (Alpha (α) Cancri), and less than half an average binocular field of view to the west of it you'll find the much fainter **M67** open cluster, best seen through a telescope. Turn to page 86 for further information about Cancer.

March's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Evening planet, best seen later in the month.

Venus
Lost in the morning twilight this month.

Mars
Morning planet lost in twilight.

Jupiter
Hanging on in the evening sky but its visibility is deteriorating, the planet losing altitude rapidly as darkness falls.

Saturn
Too close to the Sun to be seen this month.

Uranus
Evening planet, deteriorating through the month. Currently lies close to Jupiter and, like its brighter companion, is losing altitude rapidly as darkness falls.

Neptune
Not visible this month.

March's key Moon phases

LAST QUARTER
3 Mar

NEW MOON
10 Mar

FIRST QUARTER
17 Mar

FULL MOON
25 Mar

April

Don't miss the the partial solar eclipse and Lyrid meteor shower peak

8 April Small partial solar eclipse visible from western UK at sunset

11 April Mars and Saturn in conjunction (am)

20 April Jupiter and Uranus in conjunction (pm)

22 April April Lyrid meteor shower peak (unfavourable)

29 April Mars and Neptune in close conjunction (am)

NGC 1097 ▷

Massimo Di Fusco, remotely via Chilescope, Chile, 13–19 January 2023

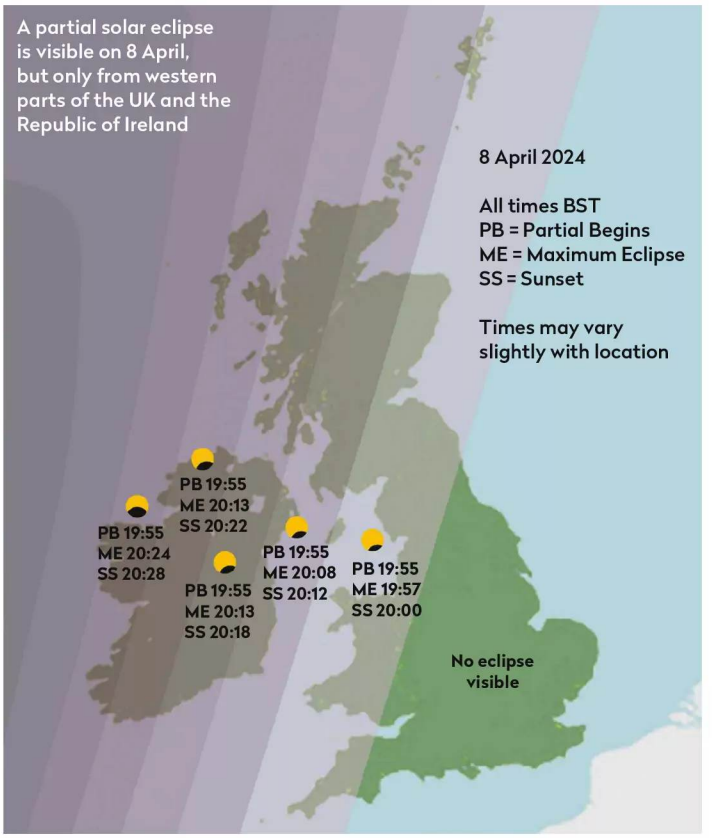
April at a glance

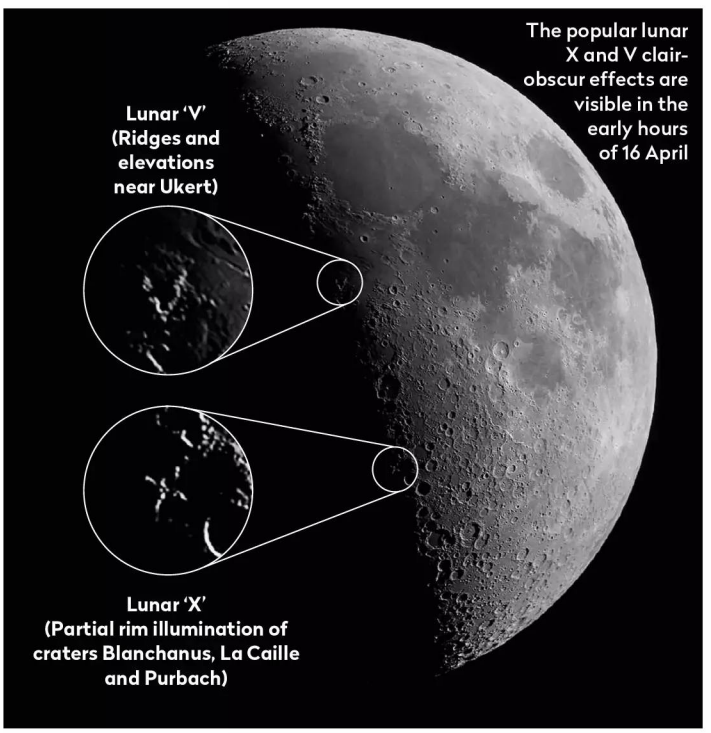
We finally lose Jupiter and Uranus to the Sun's glare this month, leaving the planetary table bare. However, there are a number of tricky twilight conjunctions. On 11 April **Mars** and **Saturn** appear 30 arcminutes apart in the dawn twilight. The twilight makes this very difficult to see. This is also the case with **Jupiter** and **Uranus** on 20 April in the evening twilight, mag. +5.8 Uranus 30 arcminutes north of Jupiter. Finally, **Mars** and **Neptune** have a close encounter on 29 April in the morning twilight, with the planets 2.5 arcminutes apart.

April traditionally marks the end of a long period without significant meteor activity, the Lyrids being the first major meteor shower of the season. The morning of 22 April is the peak of the Lyrids, although the full Moon on 23 April will spoil the show.

The theme for April 2024 is that it's a tricky astronomical month. This is echoed on 8 April when a total **solar eclipse** will be seen across parts of the United States. If you're wondering whether any of this can be seen from the UK, then the answer is yes but not much. The slimmest of partial solar eclipses can be seen from western parts of the UK at sunset, those in the northwest getting the best views.

As the Moon re-emerges from eclipse, its growing phase will become evident. During spring, the phases around first quarter are particularly well positioned after sunset. On 16 April at 03:07 UT, as the Moon approaches setting, some **clair-obscur effects** are visible. Start observing the Moon an hour or so earlier and you should be able to see the letters X and V forming on the Moon's terminator.




The popular lunar X and V clair-obscur effects are visible in the early hours of 16 April
Lunar 'V' (Ridges and elevations near Ukert)
Lunar 'X' (Partial rim illumination of craters Blanchanus, La Caille and Purbach)

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

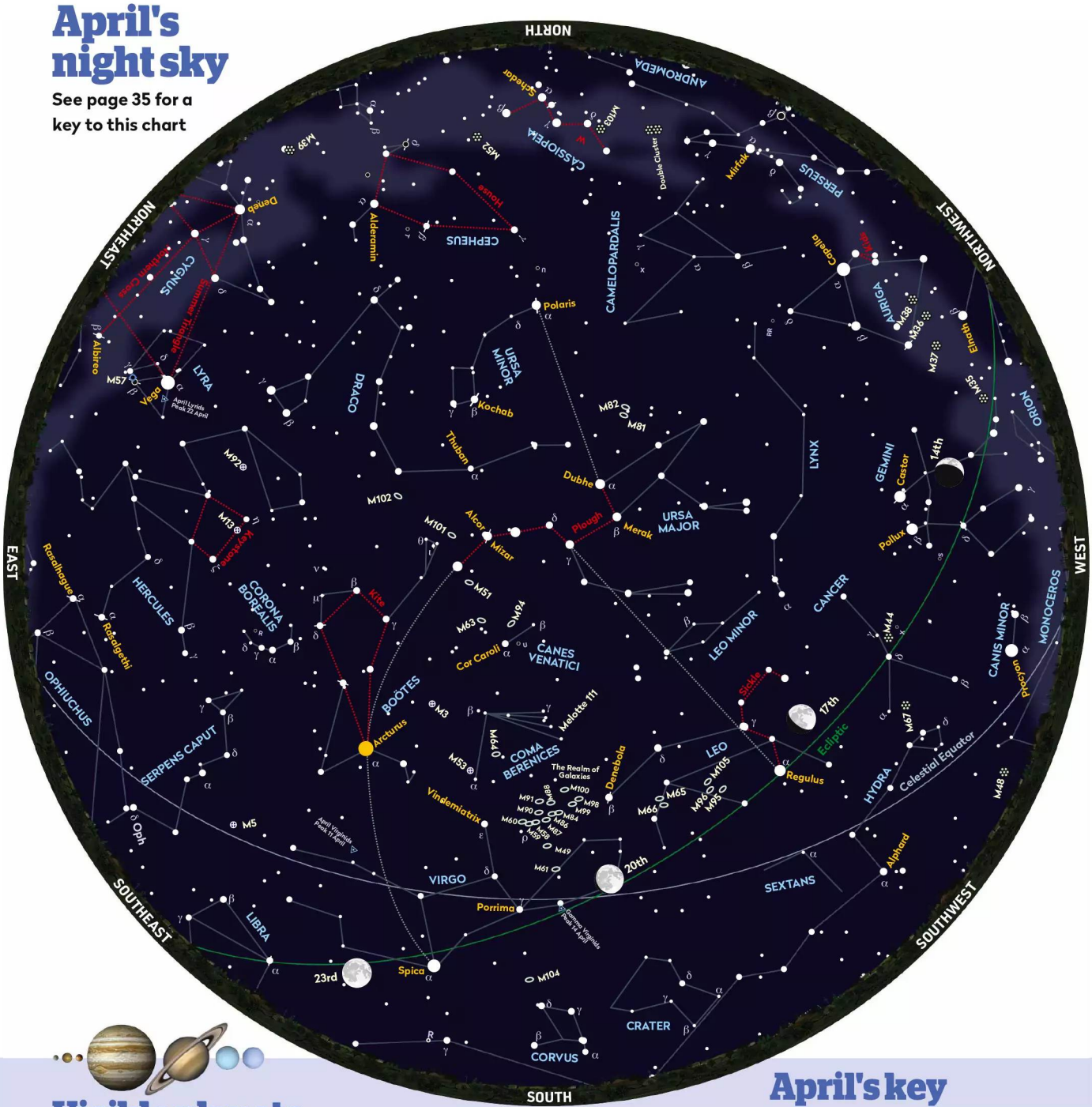
The stars of spring take centre stage this month with **Leo, the Lion** leading the march. The Lion faces west, its tail marked by the line from **Zosma** (Delta (δ) Leonis) to **Denebola** (Beta (β) Leonis). This line points at a large semicircular pattern known as the **Bowl of Virgo**. If you have trouble seeing it, imagine a large Y with the bright star **Spica** (Alpha (α) Virginis) at the bottom of the stem. Inside the bowl you're looking at the Virgo Galaxy Cluster. Using a small telescope, try and see some of the myriad galaxies located in this region.

The Virgo Galaxy Cluster extends north towards **Coma Berenices**. Before reaching the faint triangular form of the open cluster Melotte 111, you'll find more galaxies courtesy of the Coma Galaxy Cluster. Turn to page 44 for more information about Coma Berenices.

East of Coma Berenices, and pointed at by following the natural arc of the handle of **the Plough** away from the blade, you'll arrive at **Arcturus** (Alpha (α) Boötis), a bright orange star which sits at the bottom of a large kite-shaped asterism, representing the body of **Boötes, the Herdsman**. If you can identify the kite shape of Boötes, look to the east of the widest part. Here you'll find the beautifully delicate semicircular pattern known as **Corona Borealis, the Northern Crown**.

April's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Inferior conjunction on 11 April, best seen in the evening sky at the start of the month.

Venus
This planet is unlikely to be seen this month as it is too close to the Sun.

Mars
Poorly placed morning planet, which is best seen at the end of the month.

Jupiter
This planet is unlikely to be seen this month as it becomes lost in the evening twilight.

Saturn
Morning planet but poor.

Uranus
Lost to the evening glare. In conjunction with Jupiter on 20 April.

Neptune
Not visible this month.

April's key Moon phases

LAST QUARTER 2 Apr
NEW MOON 8 Apr
FIRST QUARTER 15 Apr
FULL MOON 23 Apr

May

Catch the Eta Aquariid meteor shower and look out for asteroid 2 Pallas at opposition

6 May Eta Aquariid meteor shower (am)

8 May Ultra-thin waxing crescent Moon lies near the Pleiades (pm)

14 May Waxing crescent Moon lies near M44 at 01:00 BST

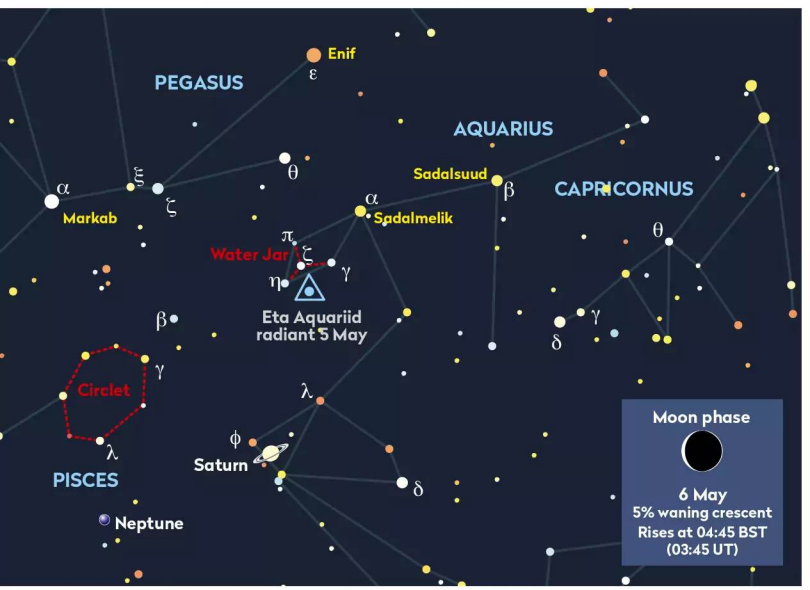
17 May Asteroid 2 Pallas reaches opposition

24 May Full Moon occults M4 and is near Antares (am)

Aurora borealis ▷

John Cuthbert, Glencoe, Scottish Highlands, 24 April 2023

May at a glance



▲ No Moon interference for this year's Eta Aquariid meteor shower peak, but astronomical dawn begins as the radiant rises from the UK

▼ Asteroid 2 Pallas reaches opposition on 17 May when it can be seen against the stars of Hercules, shining at mag. +8.9

It's a poor show for planets this month, but things will start to get better soon. Staying within the Solar System, **comet C/2023 A3 Tsuchinshan-ATLAS** should be developing nicely this month, passing across the southern part of the Bowl of Virgo and brightening all the while. Predictions have it reaching mag. +9.8 at the end of May, which is well within small telescope range. Turn to page 100 for more details.

Comets and meteor showers are intrinsically linked. The **Eta Aquariid shower** peaks on the evening of 5 May, but UK observation cannot begin until the shower's radiant is close to rising on the morning of 6 May. The absence of the Moon will help keep the sky dark, but this shower really favours those further to the south. If you get to see an Eta Aquariid trail blazing across the sky, that's a tiny piece of comet **1P/Halley** vaporising in Earth's atmosphere.

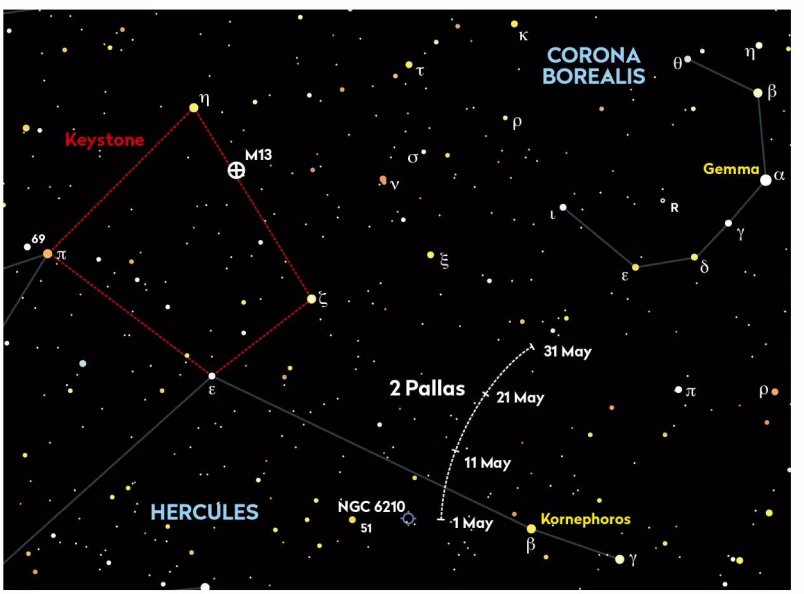
The Solar System is also represented with minor planet **2 Pallas** reaching opposition on 17 May. Located within Hercules, 2 Pallas reaches a small telescope friendly brightness of mag. +8.9 at opposition.

The Moon shows a very thin phase on the evening of 8 May, visible shortly after sunset. This less than 1% illuminated Moon will sit near to **the Pleiades** open cluster, although the bright evening twilight will make the cluster hard to see properly.

Nights in May make stargazing increasingly difficult. As we approach the Northern Hemisphere's summer solstice on 20 June, the bright and prolonged period of evening twilight reduces the night-time period to its shortest length for the year. Traditionally, the last week in May is the time to start looking out for **noctilucent cloud displays** and it'll be interesting to see what happens in 2024. Last year's displays were few and far between, possibly a consequence of increasing solar activity. If this is the reason, the prospects for 2024 may be poor too, but this is an area where observation is really important. In particular, noting the absence of a display is just as important an observation as noting a positive noctilucent cloud appearance.

The trailing constellations of spring and leading patterns of summer jostle for centre stage this month. The bright orange star **Arcturus** is very obvious, high in the southern part of the sky as darkness descends. This sits at the pointed end of a large kite-shaped asterism, the main shape in **Boötes, the Herdsman**. To the east of Boötes is **Corona Borealis, the Northern Crown**, followed by **Hercules, the Strongman**. From the UK, Hercules appears upside down, a large sprawling constellation with no really bright stars. The main pattern here is the small **Keystone asterism**, which is the guide to the fantastic deep sky object **M13, the Great Globular in Hercules**. Turn a telescope on M13 and you can't fail to be amazed.

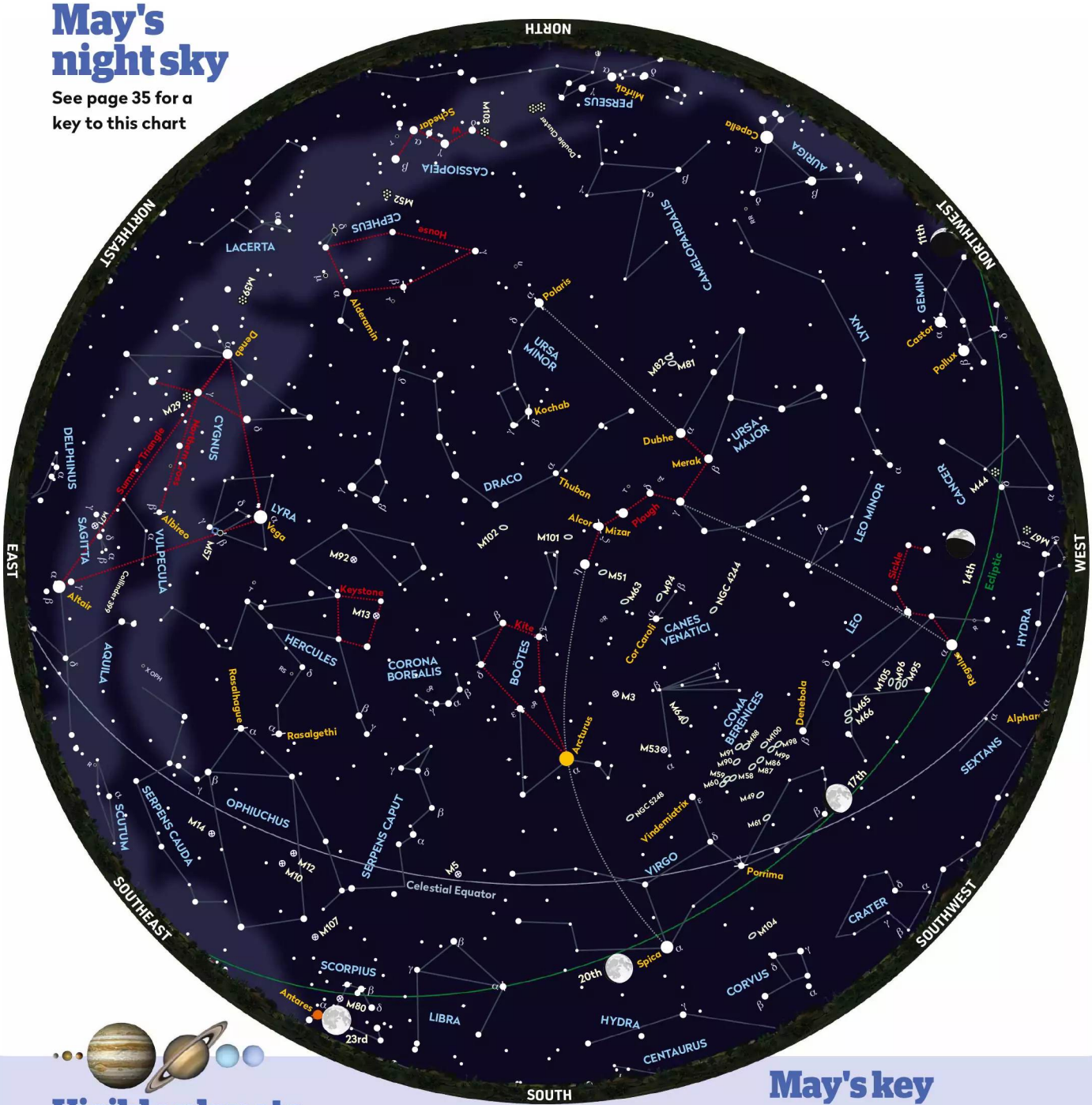
South of Hercules is the large, sparse form of **Ophiuchus, the Serpent Bearer** with the medium-bright star Rasalhague (Alpha (α) Ophiuchi) marking Ophiuchus's head near Rasalgethi (Alpha (α) Herculis). Ophiuchus is represented by a large, roughly rectangular form, the serpent he carries is represented by the constellation **Serpens, the Serpent**. Uniquely, this is split in two by Ophiuchus, the part to the west being **Serpens Caput, the Serpent's Head**, and that to the east being **Serpens Cauda, the Serpent's Tail**.



PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

May's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Unlikely to be seen this month.

Venus
Unlikely to be seen this month.

Mars
Morning planet emerging from the Sun's glare, best at the end of the month. A shallow ecliptic angle puts mag. +1.1 Mars close to the horizon, making it hard to find.

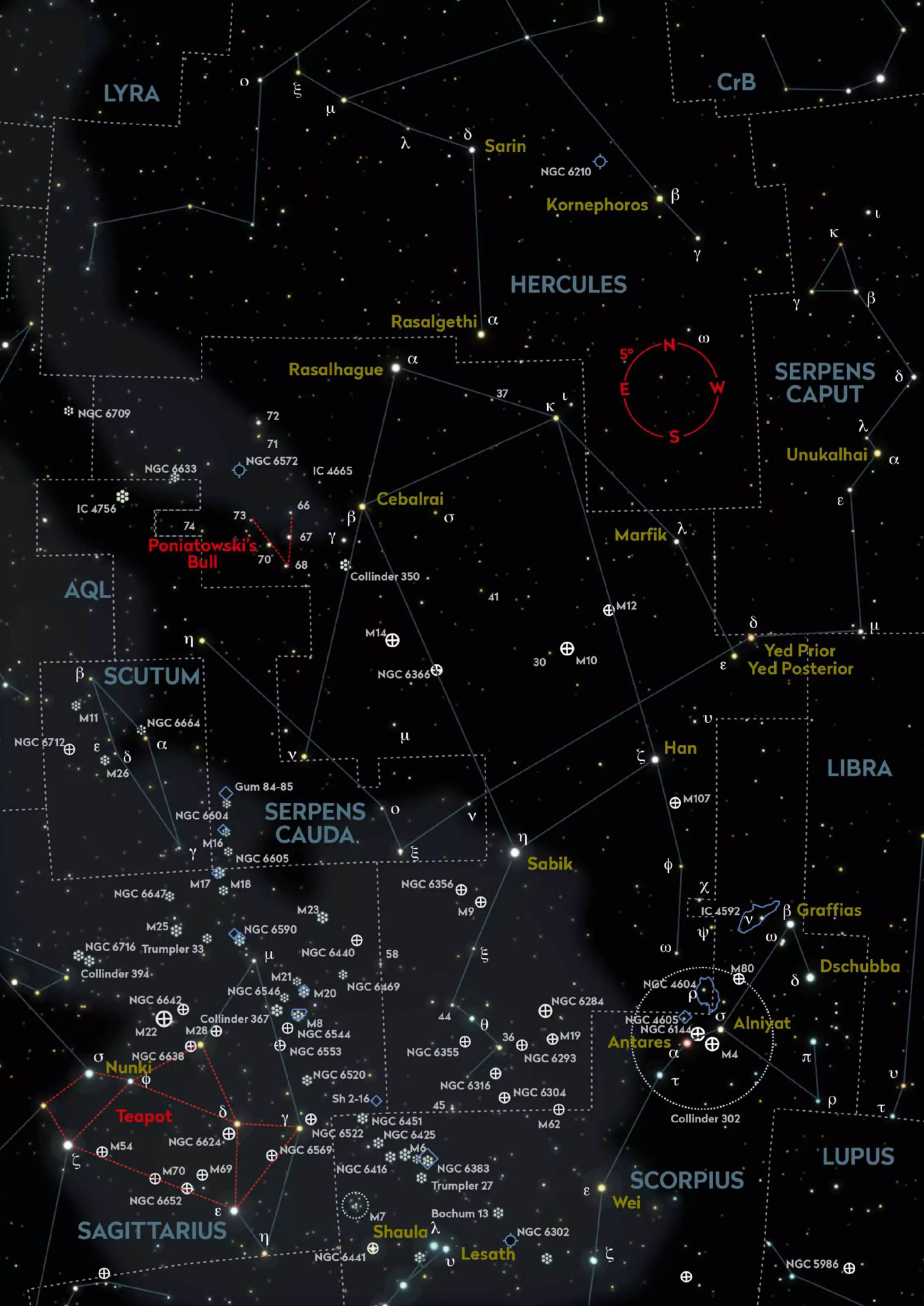
Jupiter
Solar conjunction on 18 May and unlikely to be seen this month.

Saturn
Poor visibility in the morning sky.

Uranus
Not visible this month.

Neptune
Not visible this month.

May's key Moon phases


LYRA
CrB
HERCULES
SERPENS CAPUT
SERPENS CAUDA
SCUTUM
AQL
LIBRA
SCORPIUS
LUPUS
SAGITTARIUS
Sarin
Kornephoros
Rasalgethi
Rasalhague
Cebalrai
Marfik
Unukalhai
Yed Prior
Yed Posterior
Han
Sabik
Graffias
Dschubba
Alniyat
Antares
Wei
Lesath
Shaula
Nunki
Teapot
Poniatowski's Bull
Collinder 350
Collinder 394
Collinder 367
Collinder 302
Trumpler 33
Trumpler 27
Bochum 13
Gum 84-85
Sh 2-16
NGC 6210
NGC 6709
NGC 6572
NGC 6633
IC 4665
IC 4756
NGC 6712
NGC 6664
NGC 6604
NGC 6605
NGC 6647
NGC 6590
NGC 6716
NGC 6440
NGC 6469
NGC 6546
NGC 6642
NGC 6544
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NGC 6520
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NGC 6383
NGC 6441
NGC 6356
NGC 6284
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NGC 6293
NGC 6316
NGC 6304
NGC 4604
NGC 4605
NGC 6144
NGC 5986
IC 4592
M10
M11
M12
M14
M16
M17
M18
M19
M20
M21
M22
M23
M25
M26
M28
M4
M54
M6
M62
M69
M70
M7
M8
M80
M9
M107
5°
N
E
W
S

Constellation of the season

SUMMER: Ophiuchus

The constellation of Ophiuchus initially appears as a large, barren area of sky located between the spring constellations of Boötes, Virgo and Libra, and the summer constellations of Aquila, Scutum and Sagittarius. Ophiuchus is bounded to the north by Hercules and to the south by Scorpius.

The constellation immediately to the east and west is odd in that it's the only one in the night sky that's split in two. The constellation is generally known as Serpens, the Snake or Serpent, the section to the west of Ophiuchus being Serpens Caput, the Serpent's Head, that to the east being Serpens Cauda or the Serpent's Tail. Ophiuchus represents the Serpent Bearer, which brings the whole picture together as he is depicted carrying Serpens across the night sky.

The legend of Ascelpius

There are various legends associated with the constellation, but according to Roman mythology, the constellation represents Asclepius, the Healer. He learned the secrets of healing after watching one serpent healing another with herbs. Having mastered these skills, Asclepius came under the gaze of mighty Jupiter who, fearing the human race might be on the verge of immortality, killed Asclepius with a lightning bolt, placing him in the heavens. Asclepius's staff, with a single serpent wrapped around it, is often used in the the logos of medical organisations, such as the WHO.

Ophiuchus is the 11th largest constellation by area. It takes the form of a large rectangle with a shallow, triangular roof to the north and legs dangling to the south. The apex of the 'roof' is marked by Rasalhague, a binary star which shines at mag. +2.1. The two stars have an orbital period of 8.62 years. The Arabic translation means 'head of the serpent collector'.

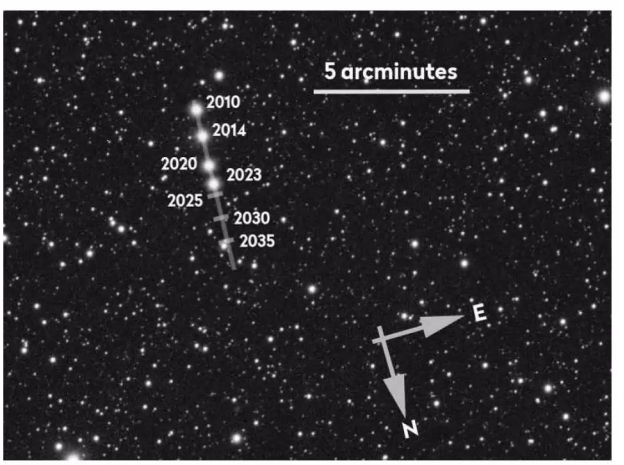
The 'roof' connects with the rectangular body at mag. +3.2 Kappa (κ) Ophiuchi to the west and mag. +2.8 Cebalrai (Beta (β) Ophiuchi) in the east. Open cluster IC 4665 sits immediately north of Cebalrai. With an integrated magnitude of +4.2 and 45 arcminutes in diameter, IC 4665 is visible to the naked eye. East of Cebalrai by 5° sits a V-shaped pattern formed by 66, 67, 68, 70 and 73 Ophiuchi, all naked-eye stars. This V, reminiscent of the V-shaped Hyades open cluster in Taurus, the Bull is an asterism known as Poniatowski's Bull. Originally part of a now-defunct constellation, the pattern honours Stanislaus Poniatowski, the King of Poland from 1764-1795.

The star at the northwest of the V, 66 Ophiuchi, is the navigational stop-off to Barnard's Star, a close neighbour of the Sun, exhibiting the largest proper motion of any night-time star.

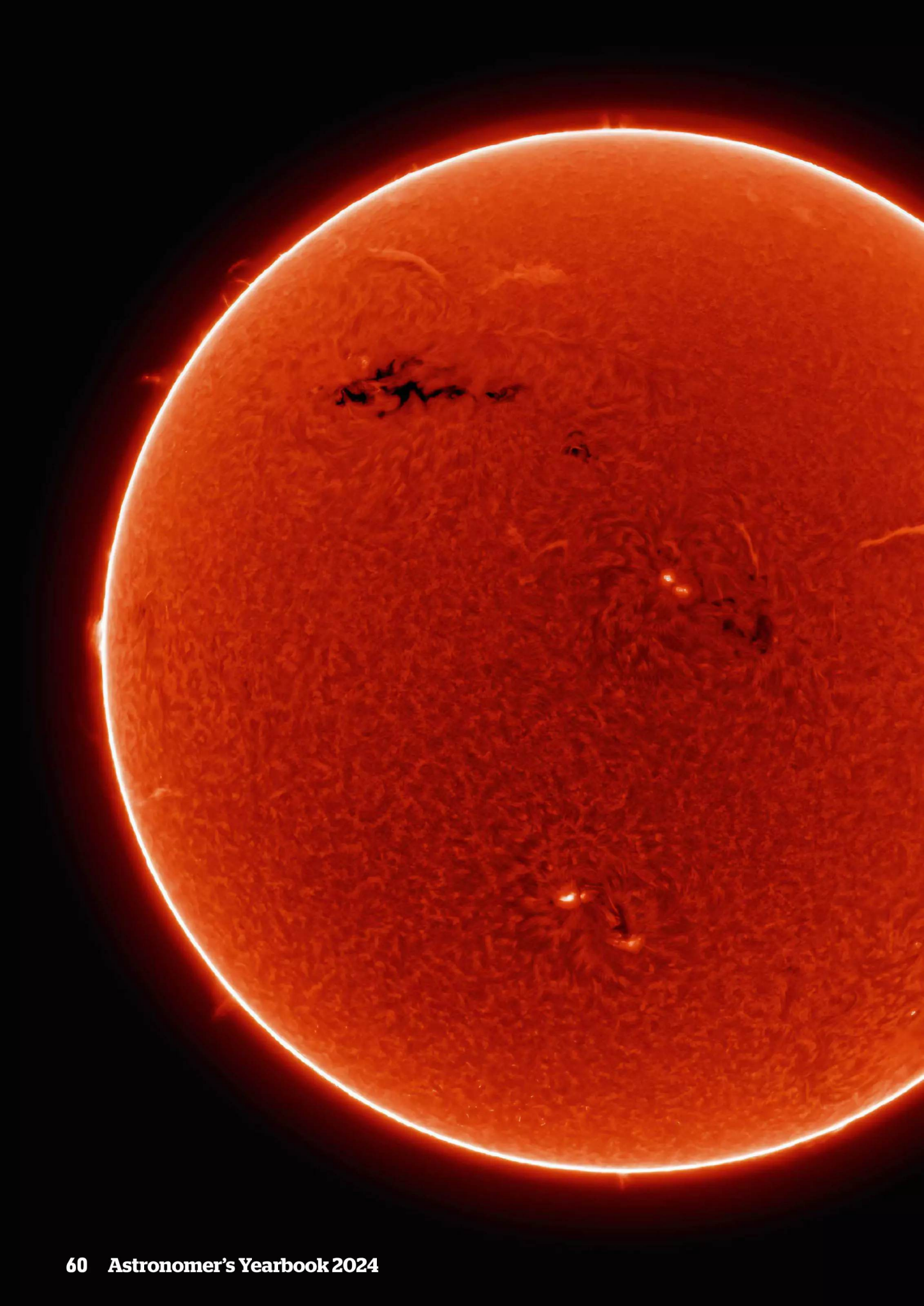
As you might imagine, a large constellation such as Ophiuchus contains a lot of deep sky objects with several included in Messier's catalogue: M9, M10, M12, M14, M19, M62 and M107, which are all globular clusters. The Milky Way clips into the northeast corner of Ophiuchus and again in the southeast, covering one of the 'legs' hanging south of the rectangular body. The southeast corner of Ophiuchus is located virtually in the direction of the Milky Way's core and here you'll find rich star fields with many dark clouds silhouetted over them. One striking example is Barnard 68, a small, beautiful, dark nebula, 1.4° north of Theta (θ) Ophiuchi.

▼ Left: IC 4665 is a large open cluster visible to the naked eye, located 1.3° northeast of Cebalrai (Beta (β) Ophiuchi)

Right: The movement of Barnard's Star against the background star field 2010-2035



ALL PICTURES: PETE LAWRENCE



June

Look out for noctilucent cloud displays and various lunar clair-obscur effects

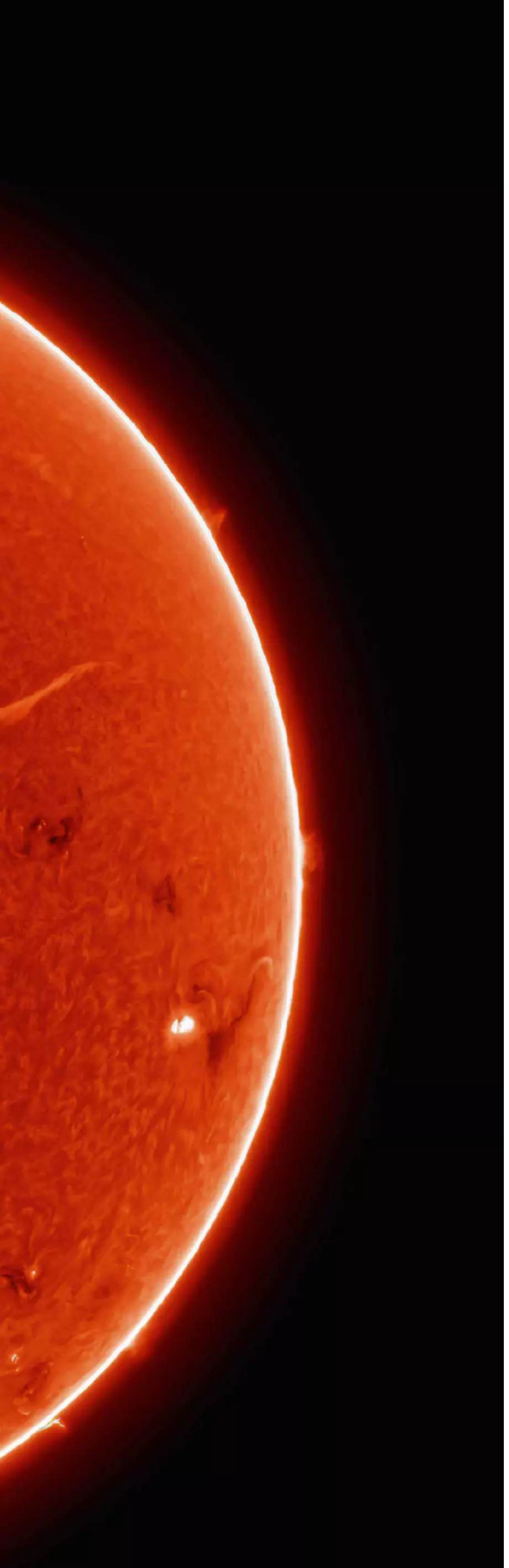
All month Possibility of noctilucent cloud displays

3 June Waning crescent Moon lies near Mars (am)

4 June Jupiter and Mercury lie half-a-degree apart (am)

20 June Northern hemisphere's summer solstice (21:50 BST)

29 June Cutlass clair-obscur effect visible on the Moon



◁ **The afternoon Sun**

Rob Lyons, Vancouver, Canada, 14 January 2023

June at a glance

The Northern Hemisphere's **summer solstice** occurs at 21:50 BST (20:50 UT) on 20 June, a time when the Sun reaches its most northerly point against the stars. From the UK, you probably don't need reminding that this also means a very limited night sky. Despite this, there's still plenty to look out for, and some things which can't be seen will bring excitement too. An example is Venus, which reaches superior conjunction on 4 June. Having languished in a poor position in the morning sky during the first part of 2024, after superior conjunction, **Venus** moves to the evening sky. Its position won't improve much until the latter part of 2024 though. **Mars** and **Jupiter** are improving in the morning sky, as is **Saturn**, although the latter needs a little more time before reaching its best.

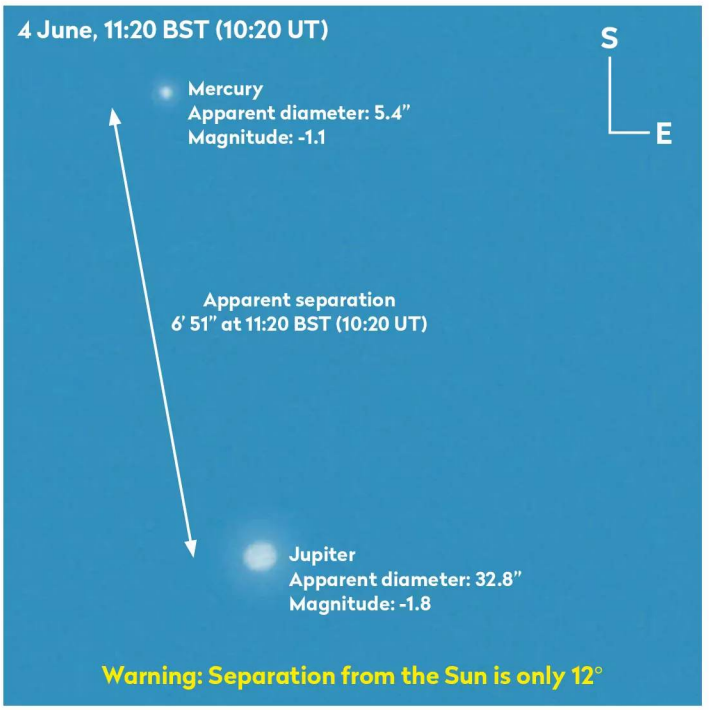
Comet C/2023 A3 Tsuchinshan-ATLAS is now well within small telescope reach, expected to reach mag. +9.0 at the end of the month. Passing from Virgo into Leo, unfortunately the lack of true darkness won't do it any favours.

There's an interesting **conjunction between Jupiter and Mercury** on 4 June. Shining at mag. –1.8, Jupiter may be seen just before sunrise above a flat northeast horizon. Mercury will be bright too, shining at mag. –1.1 on this date, located 33 arcminutes southwest of Jupiter. This will be tricky to see but, as Mercury is so bright, if you have the means to find and view it during the day, this will allow you to see the closest part of this conjunction. Both planets are slightly shy of 7 arcminutes apart at 11:20 BST. Care must be taken though, as they will be just 12° to the west-southwest of the Sun at this time.

If you can catch the 73%-lit waxing gibbous Moon in daylight on 16 June, there are a couple of interesting things to look out for here too. At 18:00 BST the Moon sits 13° above the southeast horizon. Binoculars or a small telescope should show the arc of the illuminated peaks of the **Jura Mountains** extending into the lunar night, a clair-obscur effect known as the **Jewelled Handle**. If you can see the Moon around 19:00 BST look for a tiny bright speck roughly one-third the apparent diameter of the Moon below the Moon's disc. If you can see it this, is **Spica** (Alpha (α) Virginis); a star visible in daylight.

The brief period of semi-darkness around the solstice hides all but the brightest stars at this time of year. Most prominent are the three bright stars which form the giant asterism known as the **Summer Triangle**; Deneb (Alpha (α) Cygni), Vega (Alpha Lyrae) and Altair (Alpha Aquilae). Vega is the brightest star visible nearly overhead as darkness falls. The summer Milky Way passes down through the Summer Triangle, but this is better seen in the months following June.

June represents the first major period to look out for **noctilucent clouds** (NLCs). These high-altitude ice-sheet clouds are formed when super-cooled water vapour freezes around the tiny particles left behind when a meteor vaporises in our atmosphere. If visible, NLCs are typically seen 90-120 minutes after sunset low above the northwest horizon, or a similar time low above the northeast horizon before sunrise. Big displays may persist all night long, typically starting low in the northwest, moving through north and ending low above the northeast horizon.



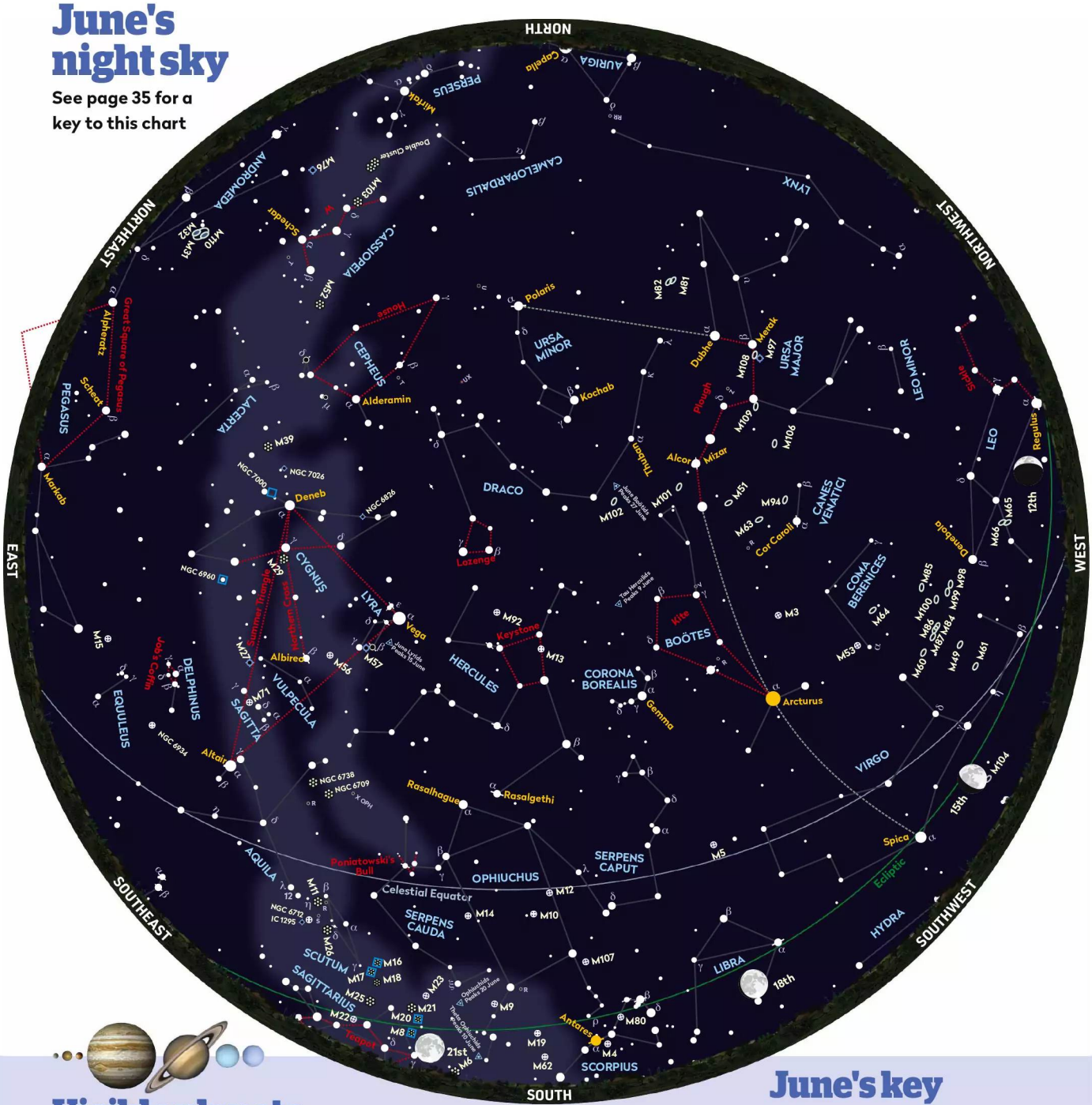
▲ On 4 June, Mercury and Jupiter can be seen half-a-degree apart

▼ The Cutlass blade is formed by the Straight Wall, the handle by the Stag's Horn Mountains at its base

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

June's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Superior conjunction 14 June, best in the evening sky at the end of June when it can be seen shining at mag. -0.5, located 10° east of Venus.

Venus
Unlikely to be seen this month.

Mars
Improving morning planet, rises nearly three hours before sunrise at the end of June.

Jupiter
Improving morning planet, close daylight conjunction with Mercury on 4 June.

Saturn
Morning planet with poor visibility.

Uranus
Not visible this month.

Neptune
Not visible this month.

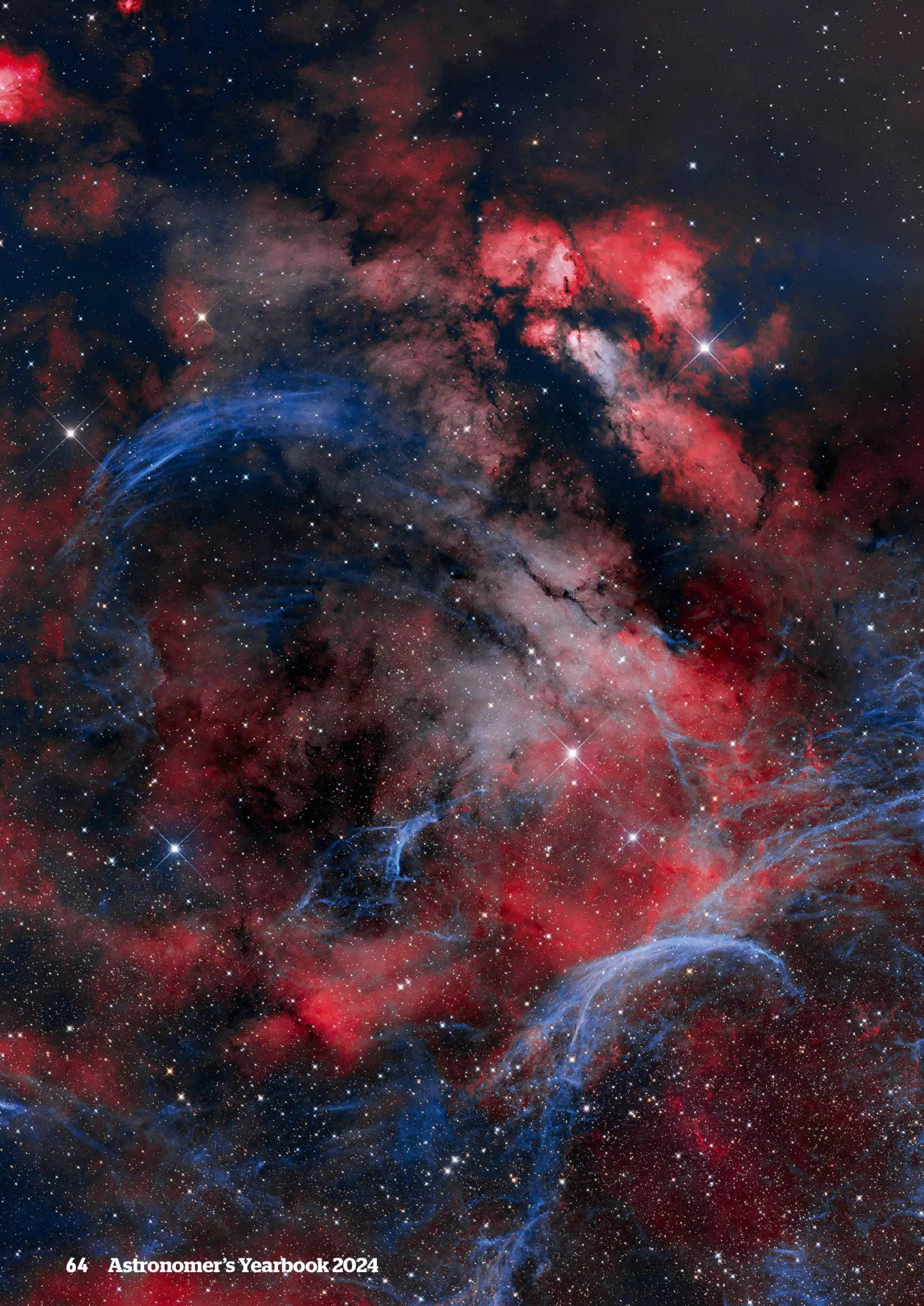
June's key Moon phases

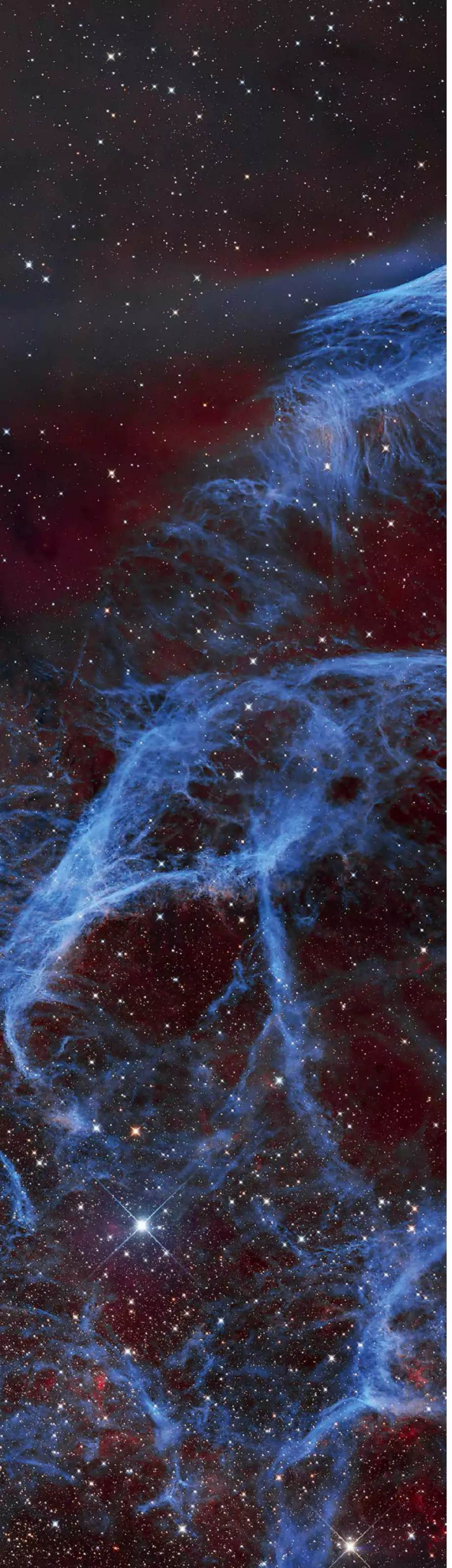
NEW MOON
6 June

FIRST QUARTER
14 June

FULL MOON
22 June

LAST QUARTER
28 June





July

Don't miss lots of chances to see planetary conjunctions and Ceres at opposition

All month Possibility of NLC displays

1 July Mars lies near the waning crescent Moon (am)

6 July Ceres reaches opposition

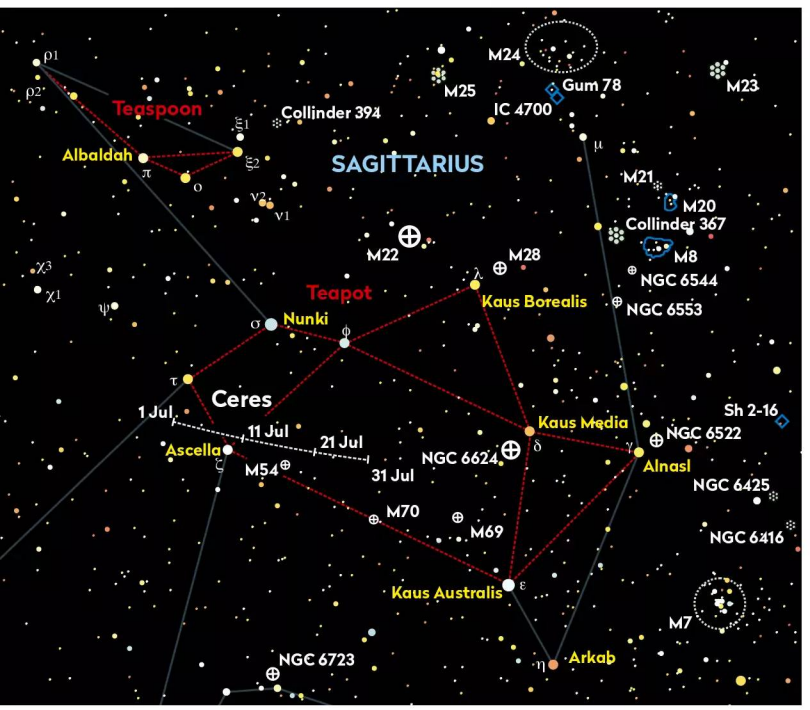
15 & 16 July Mars and Uranus in conjunction (am)

30 July Mars, Jupiter, Uranus and crescent Moon in Taurus (am)

◁ **Vela supernova remnant**

Vikas Chander, remotely via Deep Sky Chile, 1–12 April 2023

July at a glance



▲ Dwarf planet Ceres passes into the Teapot asterism, with opposition on 6 July

▼ The end of July sees a morning gathering of the Moon and planets

Noctilucent cloud season continues throughout July and into the start of August. What will 2024's season hold? Only time will tell, but 2023's was poor in terms of display counts. One possible reason for this is the rise in **solar activity**. On the plus side, with the Sun high in the UK's sky at the moment, if you have the means to view it safely there's potential to see a lot of activity. The next solar cycle peak is predicted for July 2025 with an uncertainty of eight months either way.

The UK's bright summer skies hinder views of the stars and planets at the start of July, but it's worth holding on because things are changing. **Jupiter** is currently in Taurus, the Bull, 5° north of Aldebaran (Alpha (α) Tauri) on 4 July. On 30 July, with Mars approaching Jupiter's position and Uranus located south-southwest of the Pleiades open cluster in Taurus, a 28%-lit **waning crescent Moon** joins the scene. Given clear skies, this is a perfect photo opportunity.

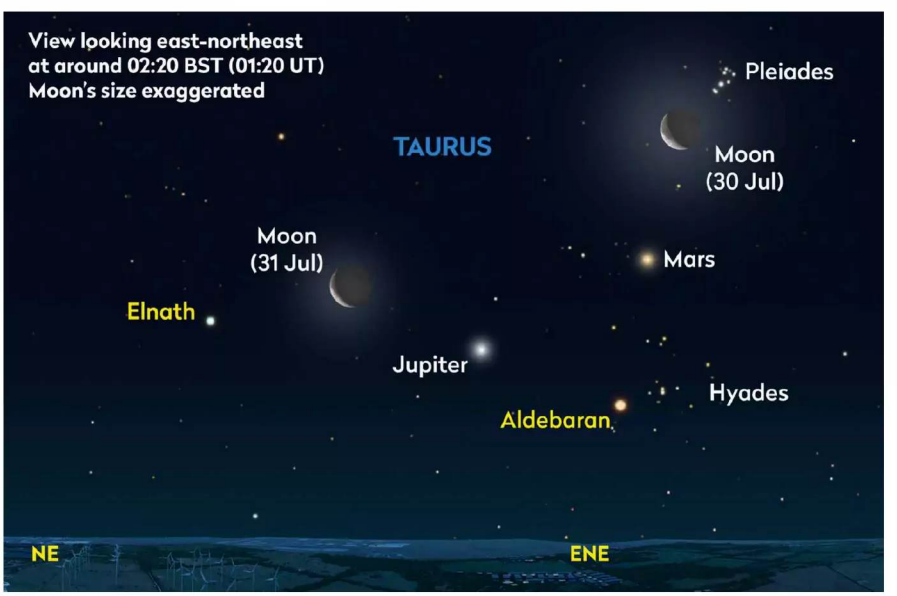
Mars's movement towards Jupiter takes it close to Uranus mid-month. On 15 July both planets appear separated by 39 arcminutes, **Mars** at mag. +0.9 and **Uranus** +5.8. Again, this is a great photo opportunity, as both planets are 6° south-southwest of the Pleiades at this time.

On 17 July, the red supergiant star **Antares** (Alpha Scorpii) lies 43 arcminutes north of the 84%-lit waxing gibbous Moon's centre at 21:00 BST. If you struggle to see Antares under daylight conditions, it's still visible close to the Moon as the sky begins to darken. For reference, the Moon's apparent diameter is approximately 30 arcminutes.

As darkness begins to set in later in the month, the summer stars and constellations burst into view. The giant **Summer Triangle** asterism is evident, and with dark skies you should be able to see the **Milky Way** passing south-southwest through it. The star in the northeast corner (upper-left from the UK) is **Deneb** (Alpha (α) Cygni), a bright and distant star which sits at the top of another asterism known as the **Northern Cross**. The beautiful telescopic double star Albireo (Beta (β) Cygni) sits at the southern end of the Cross, the Milky Way appearing to flow down through the pattern. This asterism is unlike the Southern Cross, Crux, which is the smallest constellation of them all and one which can't be seen from the UK.

The part of the Milky Way passing down the Northern Cross is bright from the UK and appears to split in two due to a dark dust lane. This is known as the **Cygnus Rift**. The brightest part of the Milky Way should be further to the south, in the direction of our Galaxy's core, but atmospheric attenuation reduces its presence. This is where you'll find the upper part of the truncated constellation **Sagittarius, the Archer**, best identified by another asterism known as **the Teapot**.

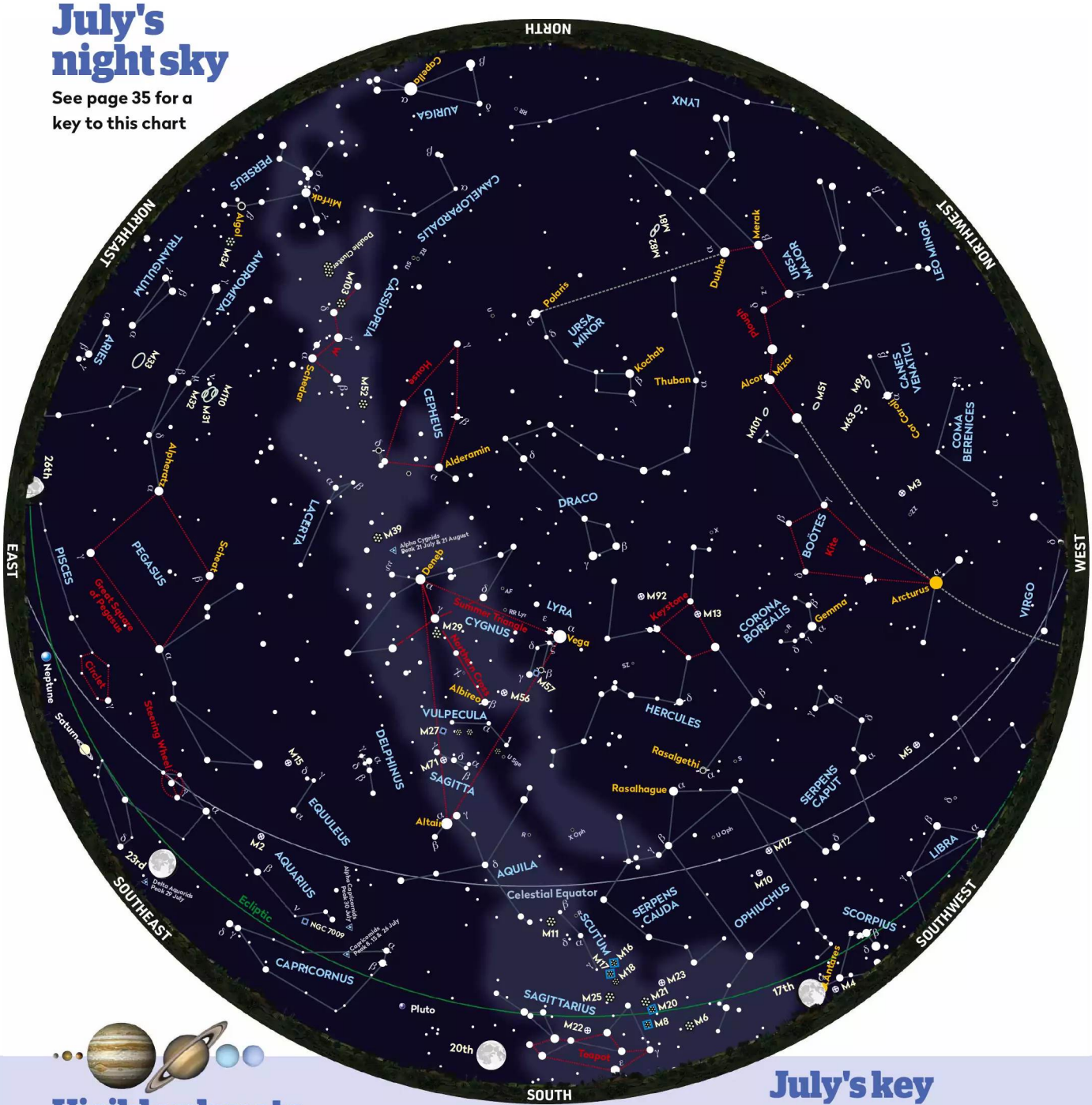
Dwarf planet **Ceres** reaches opposition on 6 July. Shining at a binocular friendly mag. +7.3, it moves west into the lower part of the Teapot asterism, passing just to the north of the star Zeta (ζ) Sagittarii on 8-10 July.



PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

July's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Evening planet, not optimally placed. Best mid-month.

Venus
Evening planet, not easily visible at present.

Mars
Morning planet near Jupiter. In close conjunction with Uranus on 15 July.

Jupiter
Improving morning planet. Impressive scenes towards end of July with Jupiter close to Mars and crescent Moon, against the stars of Taurus.

Saturn
Morning planet, best visibility occurs at the end of the month.

Uranus
Morning planet in conjunction with Mars on 15 July.

Neptune
Improving morning planet, best seen at end of July.

July's key Moon phases

NEW MOON
5 July

FIRST QUARTER
13 July

FULL MOON
21 July

LAST QUARTER
28 July

August

Catch a double shadow transit of Jupiter and the peak of the Perseid meteor shower

1 August Waning crescent Moon lies near M35 after rising (am)

5 August Jupiter, Mars and Aldebaran form a right-angled triangle (am)

9 August Double shadow transit of Jupiter (am)

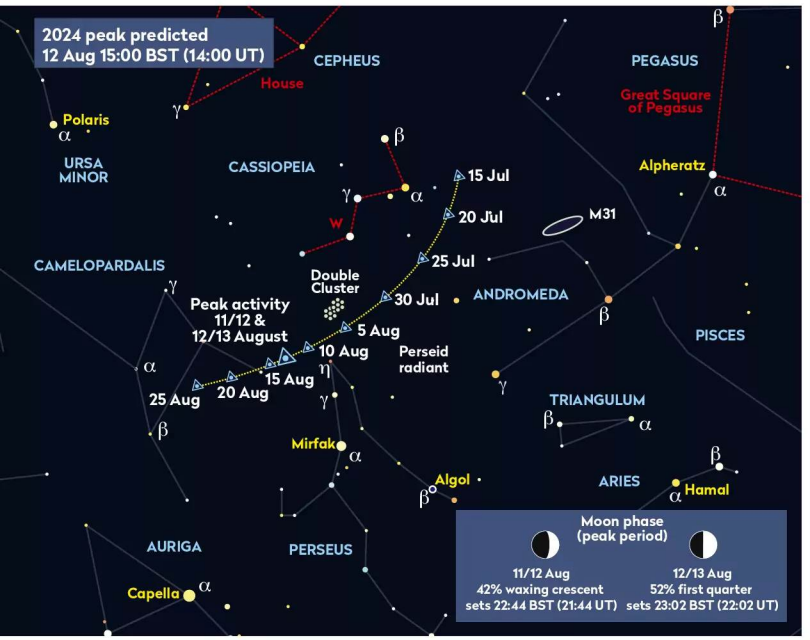
12 August Peak of the Perseid meteor shower

21 August Saturn occulted by the Moon (am)

◁ **Maximum totality**

Michael Shapiro, Farmington Hills, Michigan, USA, 8 August 2022

August at a glance



The planets return with a vengeance in August. The inferior planets aren't best placed, but Mars, Jupiter, Saturn, Uranus and Neptune are well presented. Mars, Jupiter and Uranus are within Taurus, the Bull, the beautiful stars and clusters of this Zodiacal constellation providing a great backdrop for them.

Saturn improves in bounds this month. Best seen at the end of August, it reaches its highest position in UK skies, 30° above the southern horizon, from 10 August. Excitingly, the planet is occulted by a 97%-lit **waning gibbous Moon** on the morning of 21 August as the sky brightens. Disappearance should be easy to see around 04:28 BST, but reappearance at 05:13 BST will be harder as the sky brightens. Given clear skies, both events are perfectly observable though. Times are for the UK's centre and will vary by up to several minutes depending on where you live.

A small telescope trained on Jupiter shows the planet's disc and its four bright **Galilean moons**; Io, Europa, Ganymede and Callisto. The moons frequently pass, or transit, in front of Jupiter accompanied by their shadows. On 9 August from 03:45-04:26 BST (02:45-03:26 UT) the shadows of Io and Ganymede both appear on Jupiter's disc at the same time, an event known as a double shadow transit.

August is famous for playing host to the peak of the **Perseid meteor shower**, this year predicted for 15:00 BST on 12 August. The quality of the Perseids, and of any meteor shower, is determined by the presence of the Moon; a bright Moon drowns out all but the most spectacular meteor trails. In 2023, conditions were perfect as the new Moon occurred just after the peak.

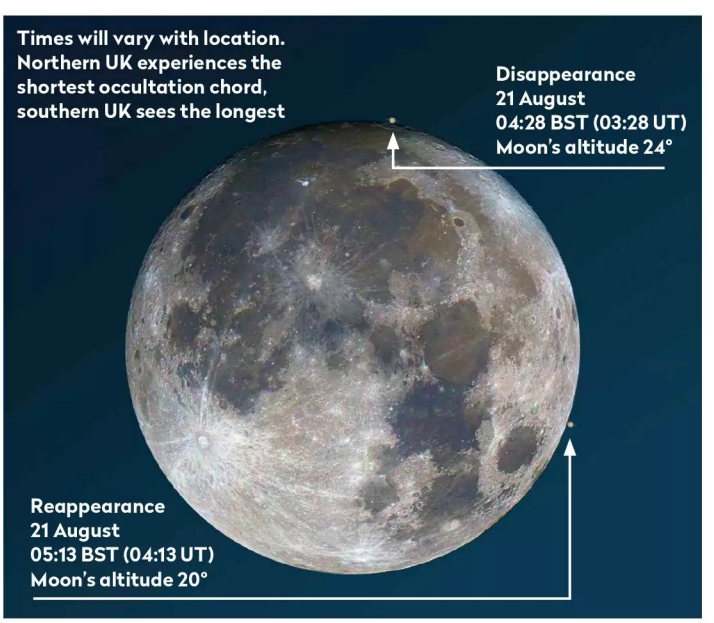
▲ The peak of this year's Perseid meteor shower is on the nights of 11/12 and 12/13 August

▼ A rare lunar occultation of Saturn can be seen in morning skies on 21 August

Peak conditions are excellent in 2024 too, the Moon at first quarter on 12 August and setting just before 22:30 BST – before the sky gets properly dark enough to watch for meteors. Consequently, a watch on the nights of 11/12 and 12/13 should deliver some excellent views, weather permitting.

The darker nights of August allow the stars of summer to shine through. The **Summer Triangle** remains prominent marked by Deneb in the northeast, Vega in the northwest and Altair to the south. Vega is the brightest star in Lyra, the Lyre, a small compact constellation which contains the beautiful **Ring Nebula**, M57. Another Lyra showpiece is the multiple star **Epsilon (ε) Lyrae** just to the northeast of Vega. Given good eyesight, this appears as two stars to the naked eye. A telescope using high magnification shows each component to be double again, an attribute which has led to Epsilon Lyrae being known as the Double-Double.

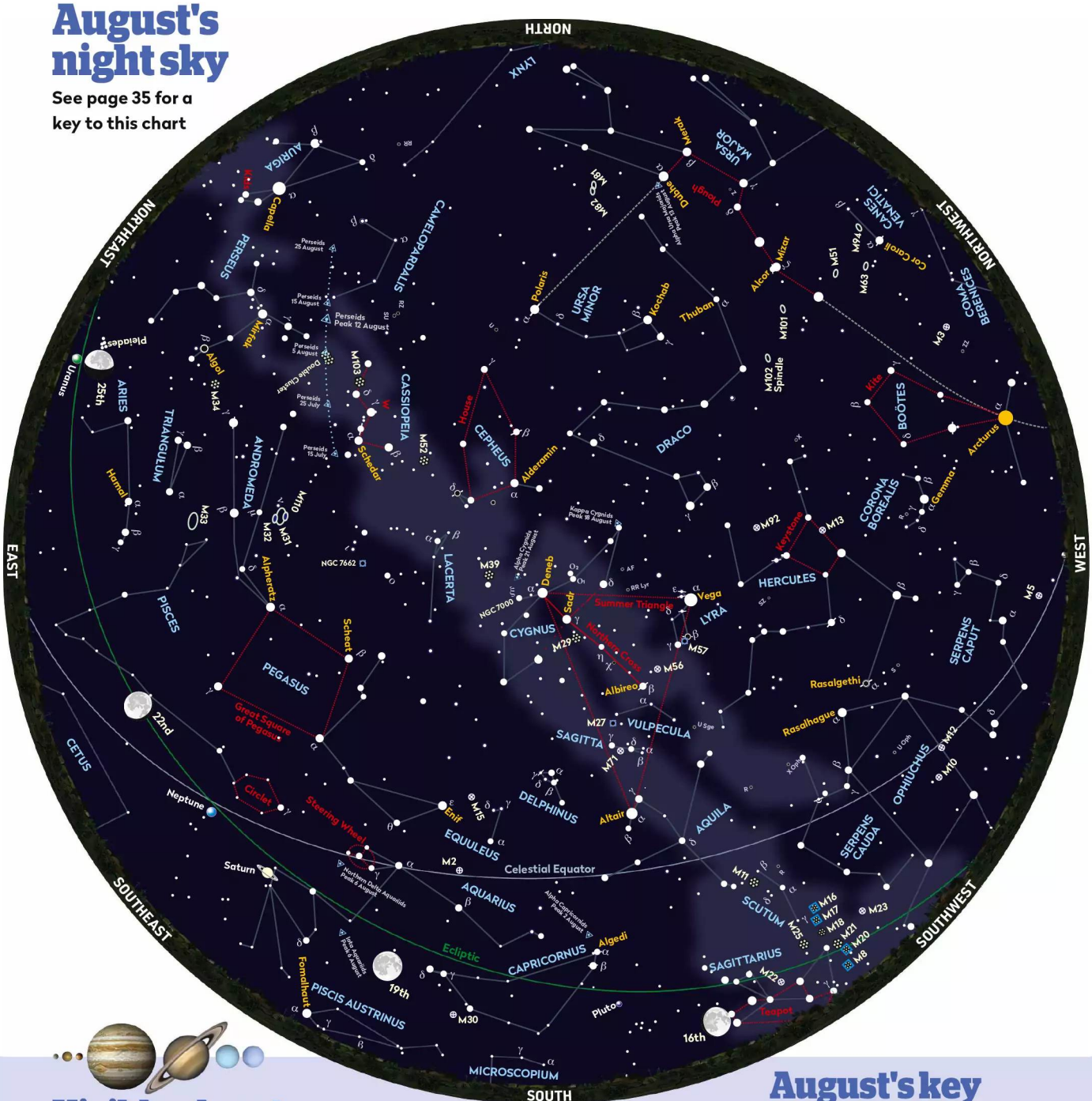
Another spectacular double is the warm yellow and azure blue pair of **Albireo** (Beta (β) Cygni) at the foot of the Northern Cross asterism. A telescope shows these colours well. A line of small constellations flows southeast from Albireo; Vulpecula, the Fox, Sagitta, the Arrow, Delphinus, the Dolphin and Equuleus, the Foal. Vulpecula plays host to the binocular bright **Dumbbell Nebula**, M27, as well as Collinder 399 or Brocchi's Cluster. Visible to the naked eye, binoculars or a small telescope reveal it has the shape of a coathanger, hence it's known as the **Coathanger Cluster**. Despite this name, it's not a true cluster at all, rather a chance, line-of-sight alignment of stars, in other words an asterism.


Times will vary with location. Northern UK experiences the shortest occultation chord, southern UK sees the longest
Disappearance
21 August
04:28 BST (03:28 UT)
Moon's altitude 24°
Reappearance
21 August
05:13 BST (04:13 UT)
Moon's altitude 20°

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

August's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Inferior conjunction 19 August, best in morning sky at end of month.

Venus
Evening planet, setting only 40 mins after Sun all month.

Mars
Improving morning planet, forming interesting patterns with Aldebaran and Jupiter.

Jupiter
Improving morning planet in Taurus. Reaching good altitude of nearly 40° under dark skies at end of month.

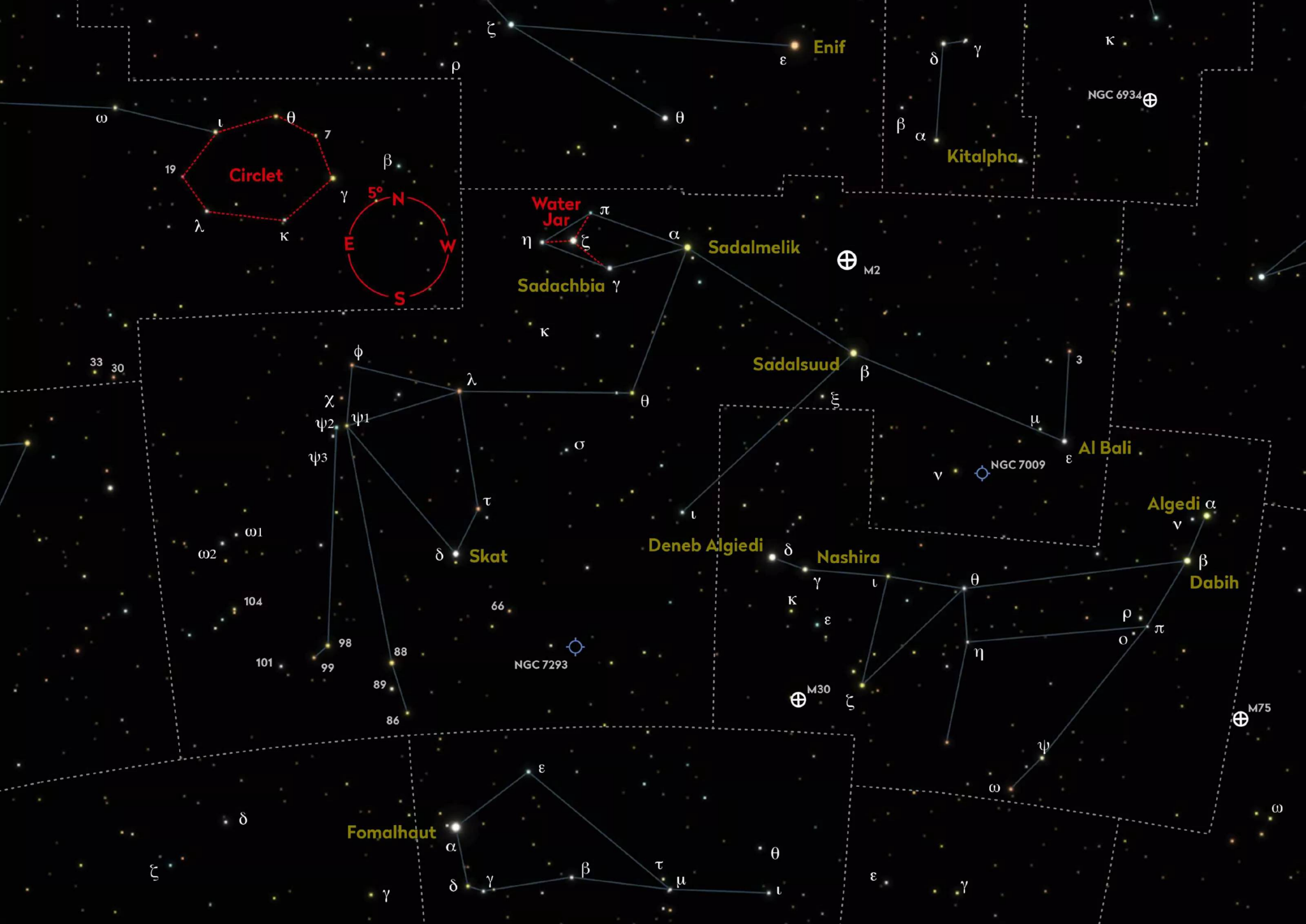
Saturn
Improving morning planet, occulted by the Moon on 21 August.

Uranus
Improving morning planet, currently near the Pleiades.

Neptune
Morning planet able to reach peak altitude, due south, in darkness from mid-August.

August's key Moon phases

NEW MOON 4 Aug
FIRST QUARTER 12 Aug
FULL MOON 19 Aug
LAST QUARTER 26 Aug


Enif
NGC 6934
Kitalpha
Circlet
5°
N
E
W
S
Water Jar
Sadalmelik
M2
Sadachbia
Sadalsuud
Al Bali
NGC 7009
Algedi
Deneb Algiedi
Nashira
Dabih
Skat
NGC 7293
M30
M75
Fomalhaut

Constellation of the season

AUTUMN: Aquarius

Aquarius is located in a region of sky called 'the sea', due to the aquatic creatures represented – Capricornus, the Sea Goat; Piscis Austrinus, the Southern Fish; Cetus, the Sea Monster or Whale; and Pisces, the Fish. To the north is Pegasus, the Flying Horse.

The constellation itself represents the Water Bearer. In one story it represents the Babylonian god Ea carrying an overflowing vase. In Greek mythology Aquarius represents the youth Ganymede who was taken to Mount Olympus by the eagle Aquila to act as cup-bearer to the gods.

The constellation is sprawling. It contains just two stars brighter than mag. +3.0; Sadalmelik (Alpha (α) Aquarii) and Sadalsuud (Beta (β) Aquarii) both shining at mag. +2.9. The western portion lacks any recognisable shapes, but to the north and east there are interesting features. In the southeast corner are three groups of three stars, each arranged in small arcing patterns. The northern group consists of Psi^1, Psi^2 and Psi^3 Aquarii. From Psi^1, two 'legs' representing the edges of the water stream flowing from Aquarius's jar appear further to the south; the remaining arcs formed by 98, 99 and 101 Aquarii to the east and 88, 89 and 86 Aquarii to the west.

To the north is the most distinctive pattern in Aquarius, a small group or four stars arranged as three in a triangle and one in the centre. The pattern measures approximately 3° across and represents the Water Jar asterism – or the Steering Wheel, as central star Zeta (ζ) Aquarii forms the centre of the wheel with three spokes ending at Gamma (γ), Eta (η) and Pi (π) Aquarii.

Aquarius contains three Messier objects, globular clusters M2 and M72, together with M73, which is a little more checkered. M73 was listed as a sparse open cluster but after modern scrutiny, the six main stars aren't close enough to be regarded as a cluster, so it's now regarded as an asterism.

Globular cluster M2 is a rich, bright object located four-and-three-quarter degrees north of Sadalsuud. It shines with an integrated magnitude of +6.5 and appears 16 arcminutes across. It contains an estimated 150,000 stars in a spherical volume 175 lightyears across, making it one of the largest globulars currently known.

Intriguing nebulae

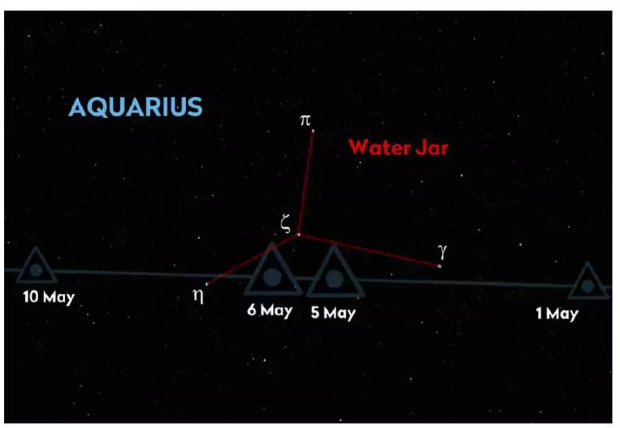
Aquarius also contains two interesting and very different planetary nebulae. The first is NGC 7293, a large object listed at magnitude +7.6. However, this is misleading. Also known as the Helix Nebula, this planetary is one of the closest of the bright planetaries to Earth with a Gaia-measured distance of 655 lightyears. This is the reason why it appears at the size it does in our sky, the Helix having an apparent diameter of 25 arcminutes. Due to its large size, its surface brightness is low at 20.8 magnitudes per square arcsecond, so it's hard to observe. Try a wide-field instrument, such as binoculars or a small telescope with low magnification.

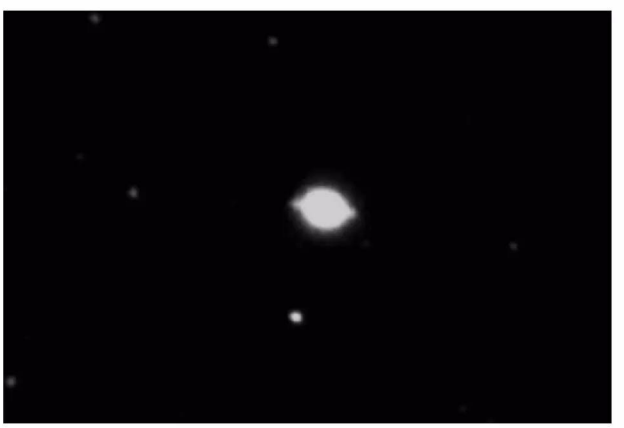
Another planetary is NGC 7009, the Saturn Nebula, as its two extensions or ansae make it look a bit like Saturn. NGC 7009 shines at mag. +8.0 and has an elliptical central core measuring 25x17 arcseconds, the 'rings' extending the object's width to around 40 arcseconds.

Aquarius plays host to several meteor showers, such as the Southern Delta Aquariids (12 July-23 August, peak 30 July) and the Eta Aquariids (19 April-28 May, peak 6 May), a shower associated with comet 1P/Halley and difficult to observe from mid-northern latitudes.

▼ Left: The Water Jar asterism conveniently marks the position of the Eta (η) Aquariid meteor shower radiant, which peaks in early May

Right: NGC 7009 is known as the Saturn Nebula, due to it having a passing resemblance to the Ringed Planet when viewed through a large scope using high magnification





ALL PICTURES: PETE LAWRENCE

September

Don't miss the plethora of planetary spectacles and an impressive Harvest Moon

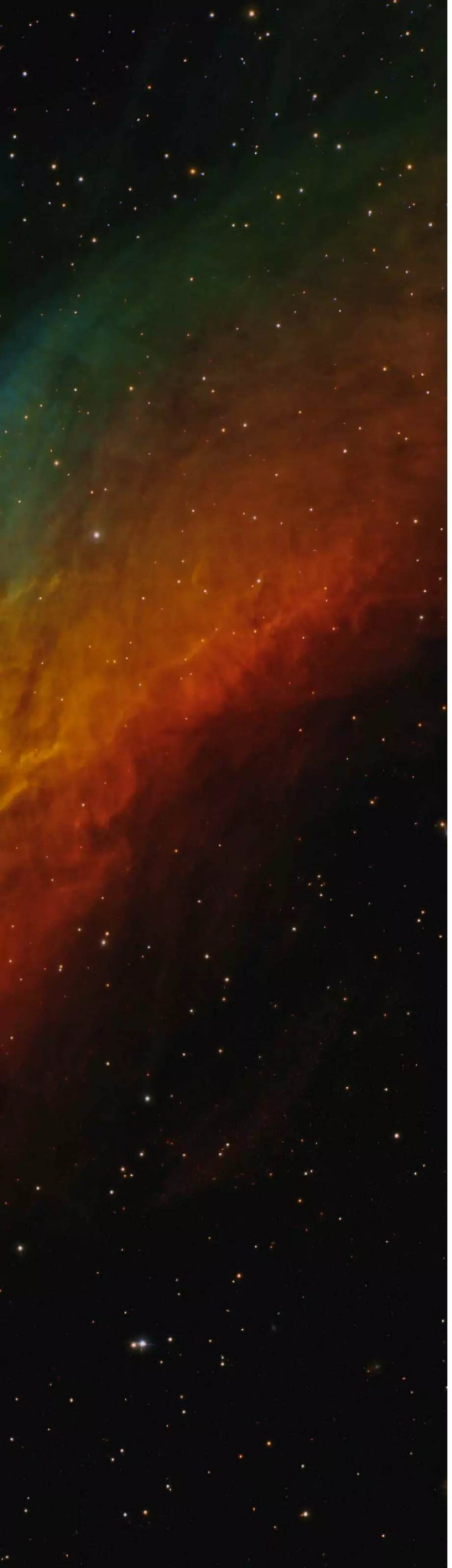
2 September Very thin Moon lies near Regulus (am)

5 September Venus lies near 5%-lit waxing crescent Moon (pm)

8 September Saturn at opposition

13/14 September Excellent Ganymede shadow transit from 23:38 BST

18 September Small partial lunar eclipse of the Harvest Moon (am)



◁ **The California Nebula**

Neil Corke, Castilléjar, Spain, January–February 2023

September at a glance

Hold on to your hats this month as there is lots happening. In terms of the planets, that old adage about how you wait forever for a bus to turn up and then two arrive at once seems to apply. After a painfully slow start to the 2024 season, the planets are back with a vengeance this month!

Saturn is at opposition on 8 September, **Neptune** on 21 September, both well-placed currently. **Mars** is slowly improving and has a brief encounter with M35 on the morning of 9 September, passing 52 arcminutes south of the cluster's centre. **Jupiter** is superb, able to reach an altitude of nearly 60° under relatively dark skies. At mag. –2.1 it's a real beacon too. Jupiter is located 3.3° east-northeast of the Crab Nebula, M1, on 30 September. **Uranus** is near Jupiter currently and this dim world rises to around 56° altitude under dark sky conditions from mid-month.

Even the inner Solar System joins in. **Mercury** rises 90 minutes before the Sun on 1 September, reaching greatest western elongation on 5 September. **Venus** improves in visibility in the evening sky, albeit very slowly. Venus sits 4.7° northwest of a 5%-lit waxing crescent Moon on the evening of 5 September and sets 50 minutes after the Sun on 30 September.

September and October will be the times to look out for **comet C/2023 A3 Tsuchinshan-ATLAS** – if it lives up to the hype. How will it perform and will it reach expectations? It's not possible to tell ahead of time, but we give you as much rational observing information as we can on page 100. This month it's predicted to brighten from mag. +4.9 to +0.3 but, be warned, it's placed in a tricky part of the sky.

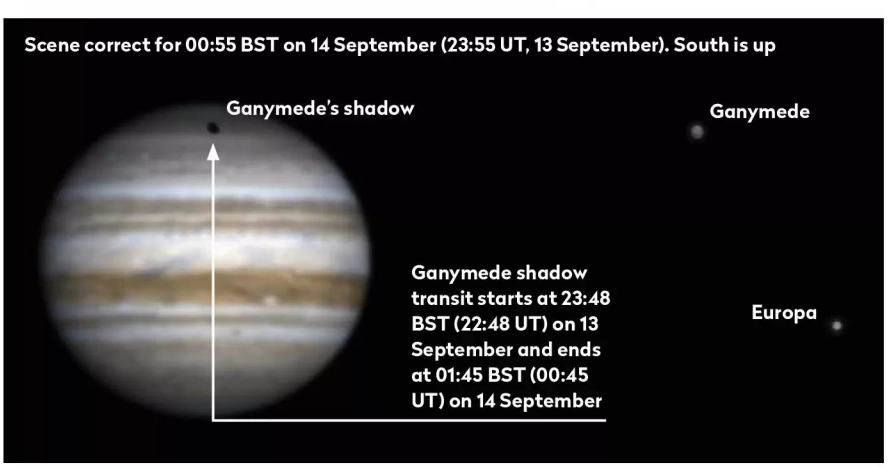
If **thin Moon** hunting is your thing, there's an excellent opportunity on 2 September, as a less than 1%-lit waning crescent sits near Regulus (Alpha (α) Leonis) in the dawn sky. If you prefer your Moon at a fuller phase, on 18 September there's a tiny partial eclipse to look forward to. This will obviously be happening to the full Moon and, occurring just four days before the Northern Hemisphere's autumn equinox, this particular full Moon takes the title of the **Harvest Moon** for 2024.

PARTIAL LUNAR ECLIPSE - 18 September 2024
Penumbral start: 01:41 BST (00:41 UT), altitude 32°
Partial start: 03:13 BST (02:13 UT), altitude 27°
Greatest eclipse (magnitude 8.5%): 03:44 BST (02:44 UT), altitude 25°
Partial end: 04:15 BST (03:15 UT), altitude 14°
Penumbral end: 05:47 BST (04:47 UT), altitude 2°

▲ A small partial lunar eclipse occurs on the morning of 18 September, the eclipsed Moon being the Harvest Moon for 2024

The stars of summer are well represented early evening. With darker skies to see them in, September is a great month for exploring the region from Cygnus, the Swan down to Sagittarius, the Archer. Despite drifting further west each day, the increase in the length of night offsets this, giving these regions an extended lease of life.

Following from the east of Cygnus is the large sprawling constellation of **Pegasus, the Flying Horse**, best recognised by the large Great Square of the Pegasus asterism. Running along the bottom of the Great Square and near its eastern side is **Pisces, the Fish**, which contains a faint but distinctive geometric asterism **the Circlet**, sitting just south of the Great Square. Below Pegasus is **Aquarius, the Water Bearer**, the current home of Saturn. It too is large and difficult to visualise, save for the small three-pronged asterism known as the **Water Jar**. To the southwest of Aquarius lies the triangular form of **Capricornus, the Sea Goat**, an ancient constellation which dates back to Babylonian times.

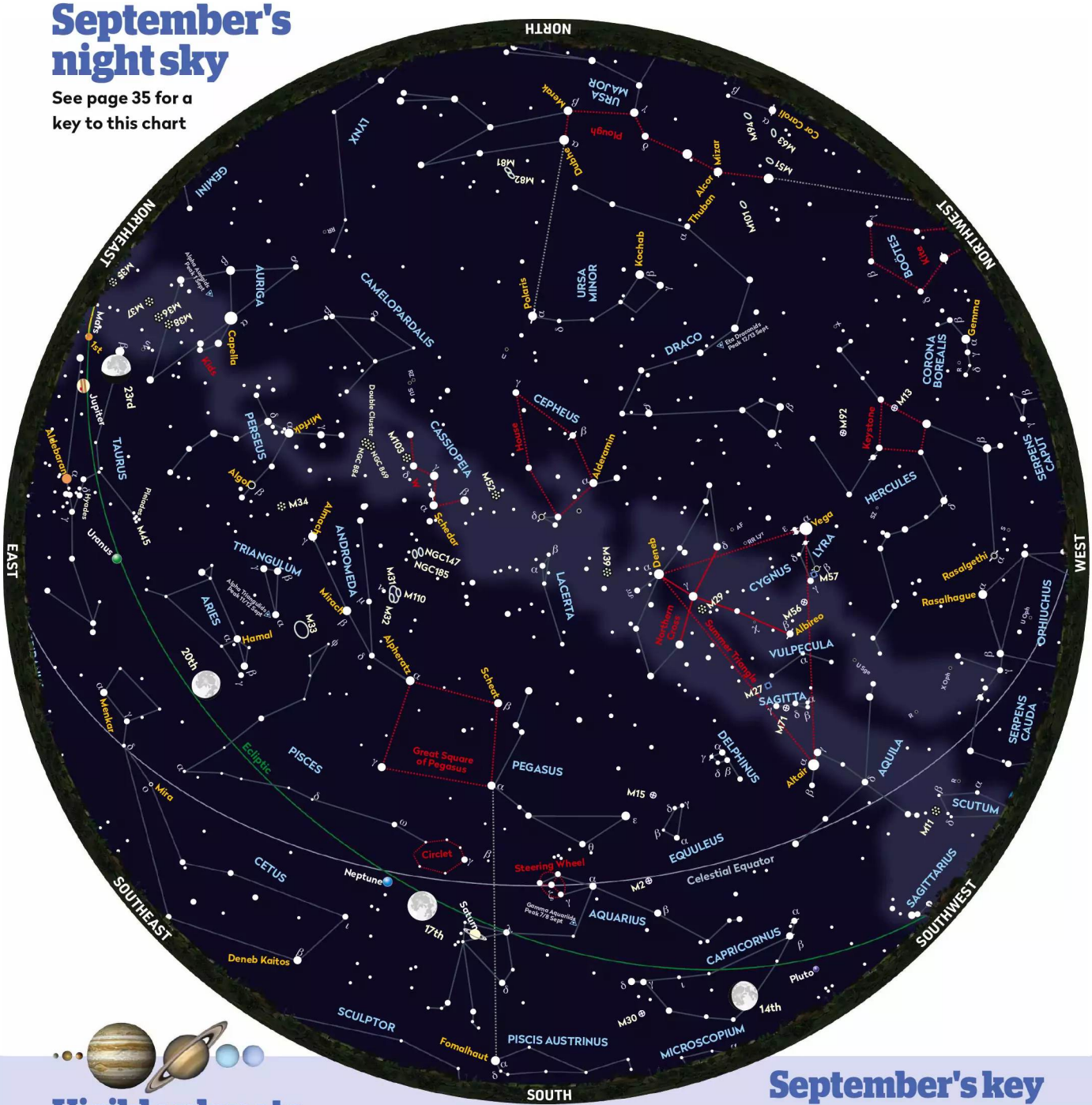

Scene correct for 00:55 BST on 14 September (23:55 UT, 13 September). South is up
Ganymede's shadow
Ganymede
Ganymede shadow transit starts at 23:48 BST (22:48 UT) on 13 September and ends at 01:45 BST (00:45 UT) on 14 September
Europa

▼ A nicely timed transit of Ganymede's shadow can be seen on the night of 13 September into the morning of 14 September

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

September's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Morning planet, best on 5 September. Superior conjunction 30 September.

Venus
Evening planet, improving slowly. Best at end of month.

Mars
Improving morning planet, near open cluster M35 on 9 September.

Jupiter
Excellent position at the end of September, reaching 60° altitude in darkness.

Saturn
Opposition on 8 September, well presented all month.

Uranus
Well placed planet, able to reach 56° altitude under dark skies from mid-September.

Neptune
Opposition on 21 September and visible at peak altitude under dark skies for the whole month.

September's key Moon phases

NEW MOON
3 Sep

FIRST QUARTER
11 Sep

FULL MOON
18 Sep

LAST QUARTER
24 Sep

October

The Moon presents all sorts of lunar spectacles with planets and the Pleiades this month

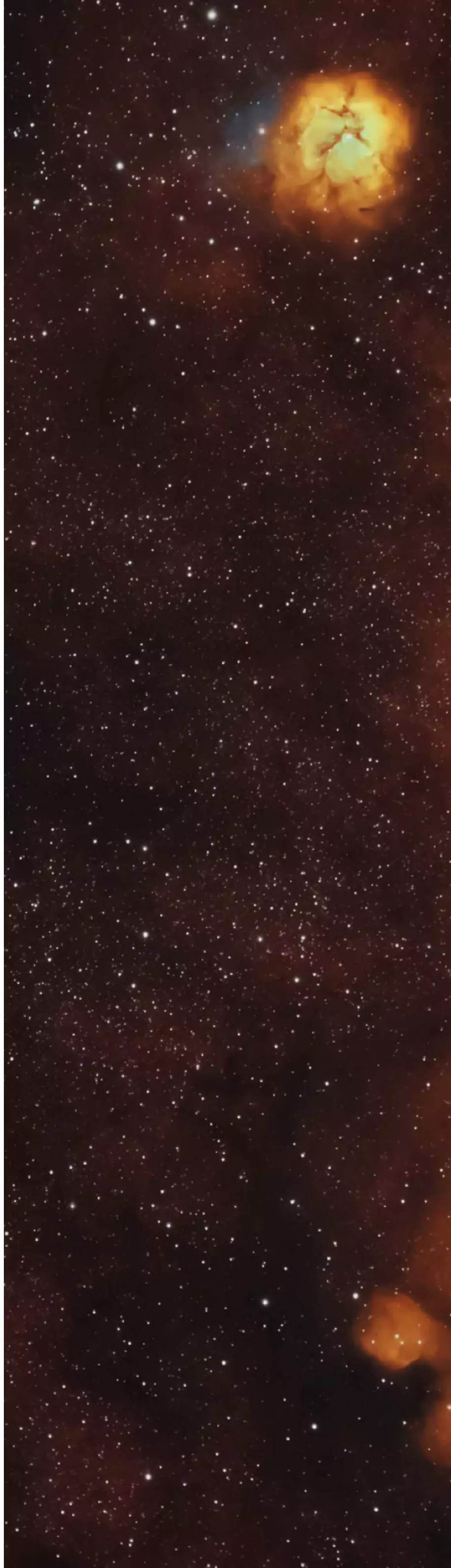
5 October Venus lies near the waxing crescent Moon (pm)

14 October Saturn very near the waxing gibbous Moon (pm)

17 October Perigee full Moon (supermoon)

19 October Lunar occultation of the southern part of the Pleiades (pm)

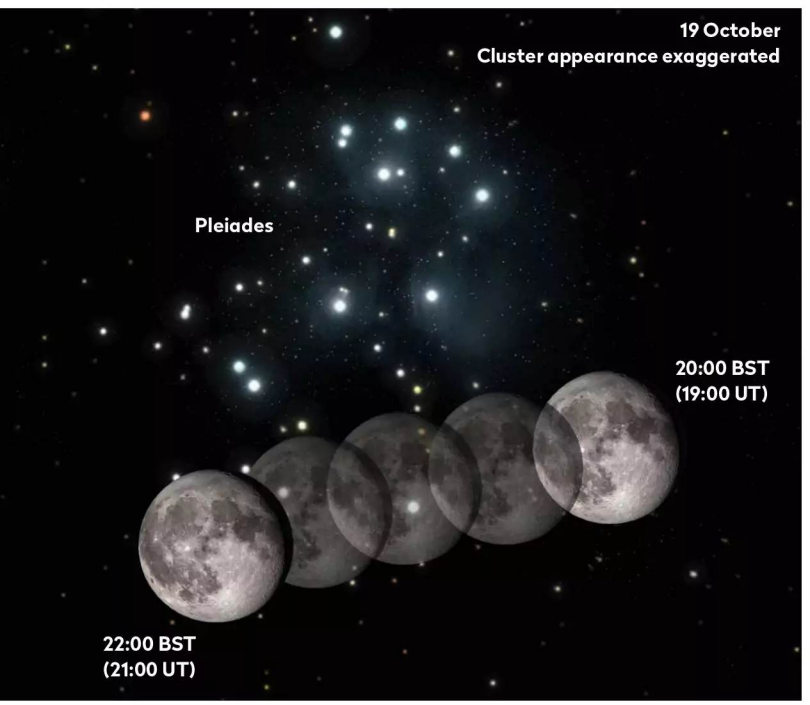
26 October Ganymede shadow transit of Jupiter from 23:42 BST (pm)



The Lagoon and Trifid Nebulae ▷

Parth Patel, Ahmedabad, Gujarat, India, 21 and 23 April, 2, 10 and 11 June 2023

October at a glance

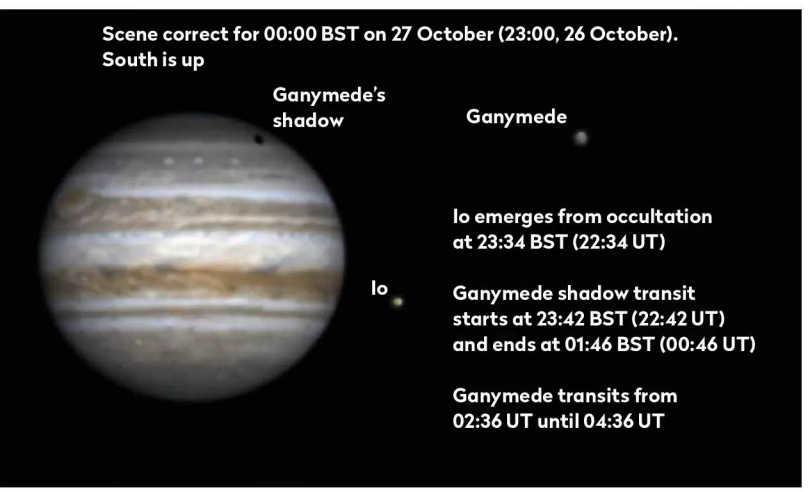


▲ The Moon crossing the Pleiades open cluster on the evening of 19 October offers a chance to see occultations

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

Darkness takes hold in October, aided towards the end of the month by the end of British Summer Time (BST). This ceases to be in effect from 27 October, when the clocks revert to UT once again.

Quite a month it will be too, with the main planets putting their best foot forward. With the exception of Mercury, all are on show this month. **Venus** sets 90 minutes after the Sun by the end of October, **Mars** brightens to mag. +0.1, **Jupiter** shines at mag. –2.3 and is able to reach its highest altitude in true darkness, as is **Saturn**, although this is dimmer at mag. +0.4. The ice giants, **Uranus** and **Neptune** are also well-presented this month – planetary heaven for those who enjoy observing these amazing objects!


Scene correct for 00:00 BST on 27 October (23:00, 26 October).
South is up
Ganymede's shadow
Ganymede
Io
Io emerges from occultation at 23:34 BST (22:34 UT)
Ganymede shadow transit starts at 23:42 BST (22:42 UT) and ends at 01:46 BST (00:46 UT)
Ganymede transits from 02:36 UT until 04:36 UT

▼ A lovely transit of Ganymede's shadow across Jupiter's disc occurs on the night of 26 October

Comet C/2023 A3 Tsuchinshan-ATLAS will be interesting this month too. Predicted to reach its brightest magnitude in October, this should place it easily within the naked eye range. How will it be presented for UK observers? Turn to page 100 to find our take on C/2023 A3.

Lunar fans are well catered for during October too. On 1 October, there's an opportunity to grab a very thin 1%-lit waning crescent **Moon** in the dawn twilight. A tricky sight at the best of times, finding such a thin Moon in the bright twilight is very rewarding. After passing new Moon on 2 October, on 5 October an easier to find 7%-lit waxing crescent Moon can be seen near bright Venus in the evening twilight. On 7 October, the red supergiant **Antares** can be seen 1.2° northwest of a 21%-lit waxing crescent Moon just before they set.

At 19:15 BST (18:15 UT) on 14 October, the now 89%-lit waxing gibbous Moon sits 53 arcminutes southeast of **Saturn**, a separation measured from the centre of the Moon's disc. As the Moon appears 30 arcminutes across, this places Saturn 38 arcminutes from the Moon's limb.

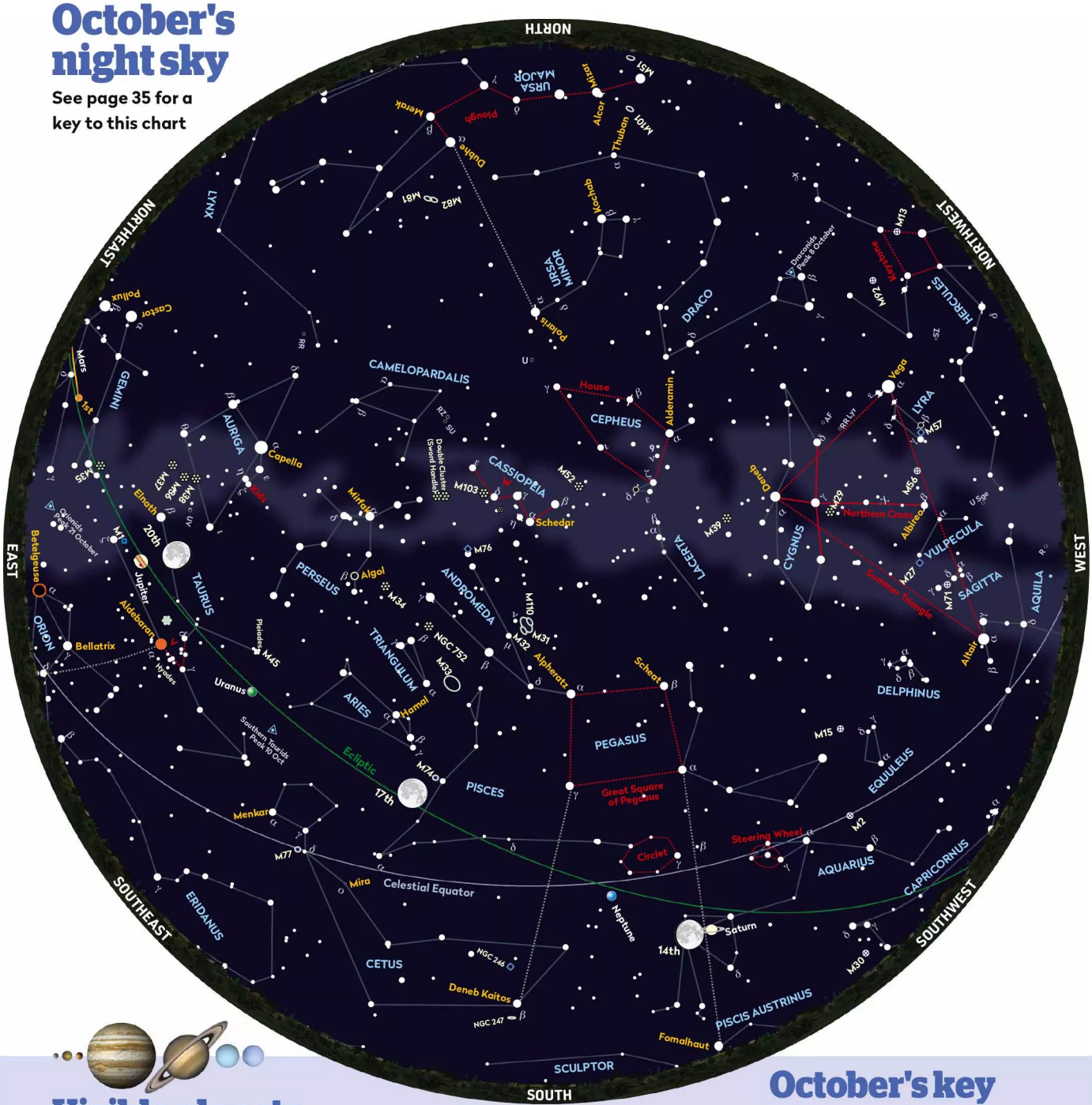
On 17 October full Moon occurs at 12:26 BST (11:26 UT), just 10 hours 40 minutes after lunar perigee. This makes the 17 October full Moon, the **Hunter's Moon**, a perigee full Moon, or supermoon. On 19 October the 91%-lit waning gibbous Moon moves in front of the southern portion of **the Pleiades** open cluster. Then as dawn breaks on 21 October, the waning gibbous Moon, now 81%-lit, sits near bright **Jupiter**.

The bright Moon on this date spells bad news for the **Orionid meteor shower** which peaks on the morning of 21 October. The last quarter Moon appears near **Mars** as they both rise around 23:00 BST (22:00 UT) on 23 October.

In terms of the stars and constellations, October gives you the best of three seasons, summer towards the west early evening, autumn centre stage late evening and winter in the early hours. The wedge-shaped constellation of **Andromeda, the Chained Princess** extends south of the northeast corner of the Great Square of Pegasus. Mid-way along the wedge lies the bright spiral galaxy **M31**, which is visible to the naked eye from reasonably dark skies. Andromeda stretches towards her husband and rescuer, **Perseus, the Greek Hero**. Her mother and father appear further to the north, represented by W-shaped **Cassiopeia, the Seated Queen** and house-shaped **Cepheus, the King**. Using binoculars, look at the region between Cassiopeia and Perseus where you'll find the spectacular pair of clusters known individually as h and Chi (χ) Persei or collectively as the **Double Cluster**.

October's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Unlikely to be seen.

Venus
Evening planet, setting 90 minutes after the Sun at the end of the month.

Mars
Well-presented morning planet currently in Gemini.

Jupiter
Superbly placed planet, best at the end of October when it's able to reach its highest altitude of nearly 60° when due south, under dark skies.

Saturn
Well-presented evening planet, reaching nearly 30° altitude when due south.

Uranus
Well-positioned planet, able to reach peak altitude, due south, in darkness all month.

Neptune
Well-presented evening planet in Pisces, visible at peak altitude under dark skies all month.

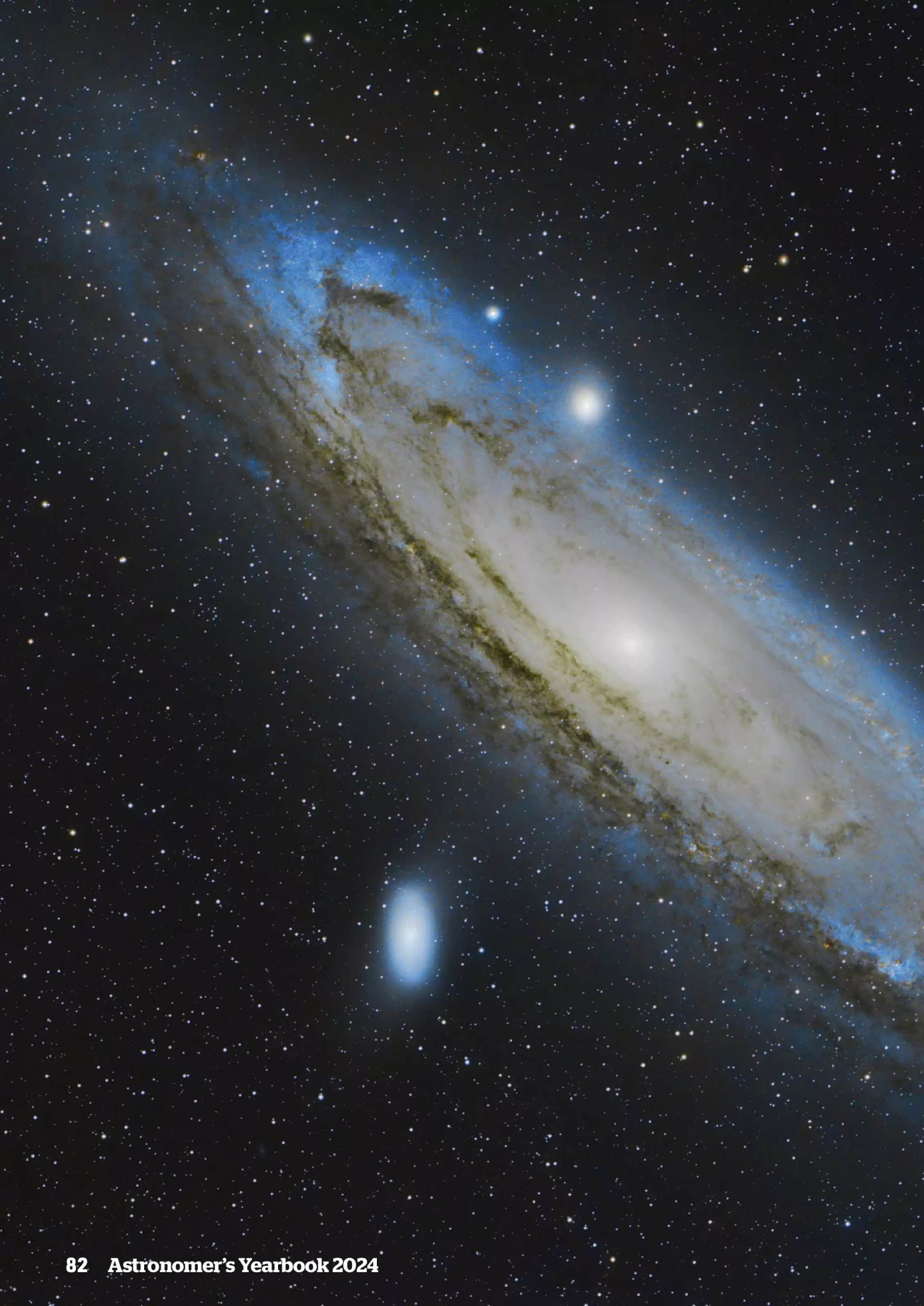
October's key Moon phases

NEW MOON 2 Oct

FIRST QUARTER 10 Oct

FULL MOON 17 Oct

LAST QUARTER 24 Oct



November

Don't miss Callisto south of Jupiter's southern pole and a rare transit of Titan's shadow

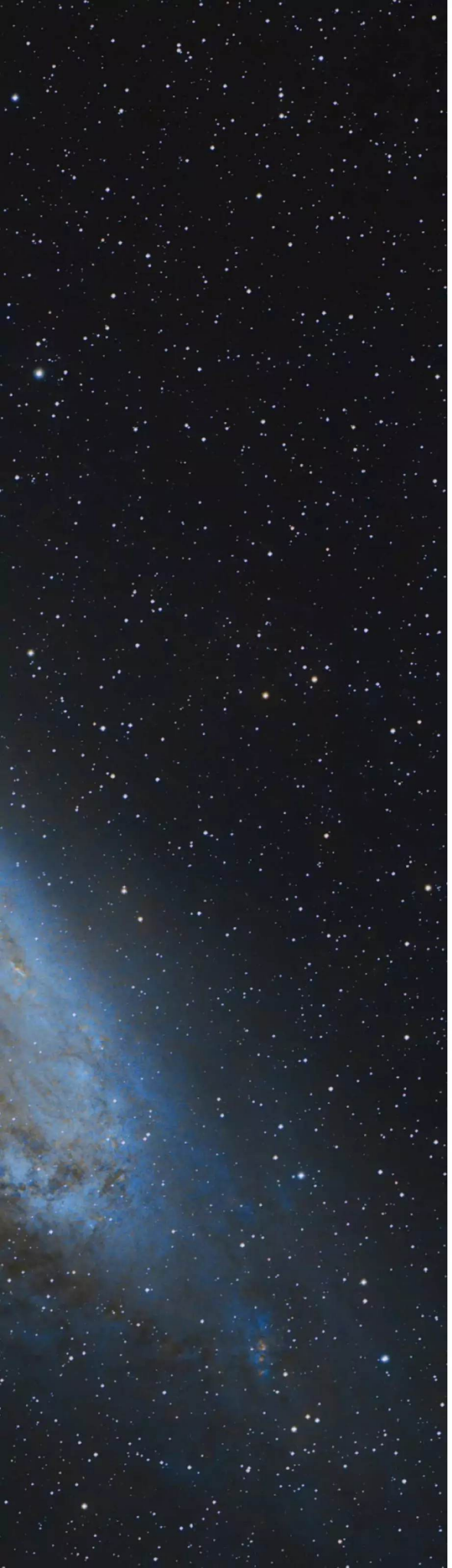
1 November Callisto lies south of Jupiter's southern pole (am)

4 November Venus near the waxing crescent Moon (pm)

4 November Rare transit of Titan's shadow on Saturn from 21:08 UT (pm)

17 November Uranus reaches opposition

30 November Mars lies near M44 (pm)



◁ **The Andromeda Galaxy**

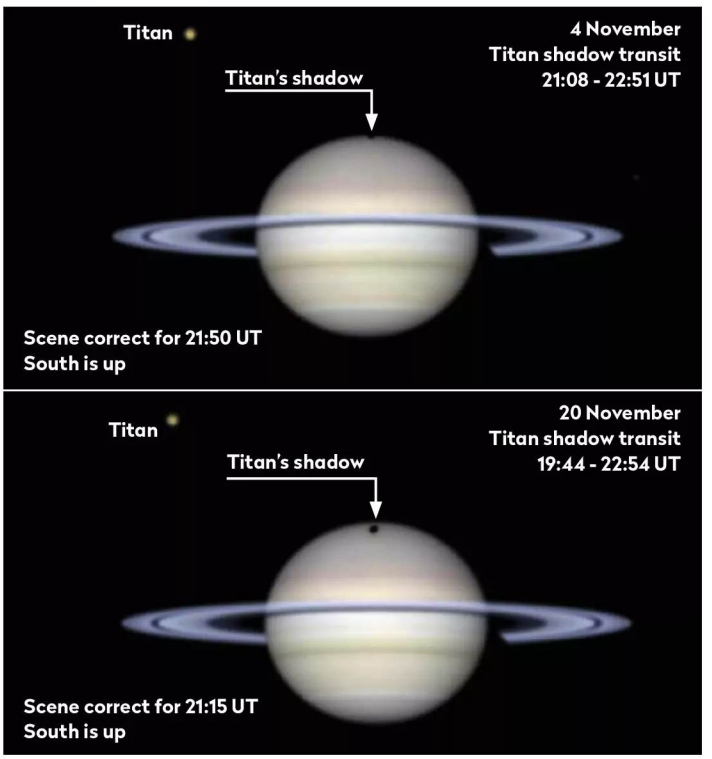
Davy Viaene, remotely via the E-EyE Observatory, Spain, 3 & 8 November 2022

November at a glance

With long, dark nights, this month is planetary observing heaven. Ahead of Jupiter's opposition on 7 December, it's **Uranus** reaching opposition this month, sitting opposite the Sun in the sky on 17 November. The **full Moon**, technically the Moon at opposition, occurs on 15 November just two days shy of lunar perigee. It lies 3.7° to the north of **Uranus** and as dawn breaks on 16 November, 2.2° southwest of **the Pleiades** open cluster. Of course, such a large bright Moon will completely swamp the delicate cluster stars to the naked eye, but binoculars should show them. This bright Moon sitting near **Jupiter** on 17 November, spells disaster for the **Leonid meteor shower**, which this year reaches its peak around midday on the 17th.

As it approaches opposition, Jupiter's four largest moons appear to transit the planet's disc almost in sync with their shadows. Using a telescope, take a look at Jupiter around 19:50 UT when you should see **Io** and its shadow close in the middle of Jupiter's disc.

When the Moon is out of the way, the stars of November's night sky are quite beautiful. Early evening the stars of late spring and summer appear in the west, the now inappropriately named **Summer Triangle** still being prominent. Early evening, following from the east and rising to centre stage due south, are the stars of autumn, led by **Pegasus, the Flying Horse**. Count how many stars you can see within the Great Square of Pegasus and this is a good indication of the quality of your sky. A count of 0 means you live under heavy light pollution, 1-4 town-class light pollution, while from a dark urban location you may see up to 13. If you can see 30+ stars you have an excellent sky.



▲ Titan's shadow transits Saturn on the evenings of 4 and 20 Nov

As we approach the latter part of the evening, the stars of **Taurus, the Bull** become well-placed. Jupiter blazes out from between the Bull's horns this month. Taurus's northern horn tip is marked by **Elnath** (Beta (β) Tauri), a star which acts as a gateway to **Auriga, the Charioteer**, located further north. Auriga appears as a misshapen pentagon with the bright star **Capella** towards the north of the shape.

Draw a line from Capella to bright **Vega** in Lyra, the Lyre, the star marking the northwest corner of the Summer Triangle. Near to the midpoint of this line sits a lone second magnitude star: the North Star, **Polaris**. An easier way to locate it is to use the two stars furthest from the handle in the Plough asterism. Known as 'the Pointers', these point directly at Polaris. **The Plough** can be seen low above the northeast horizon late evening.

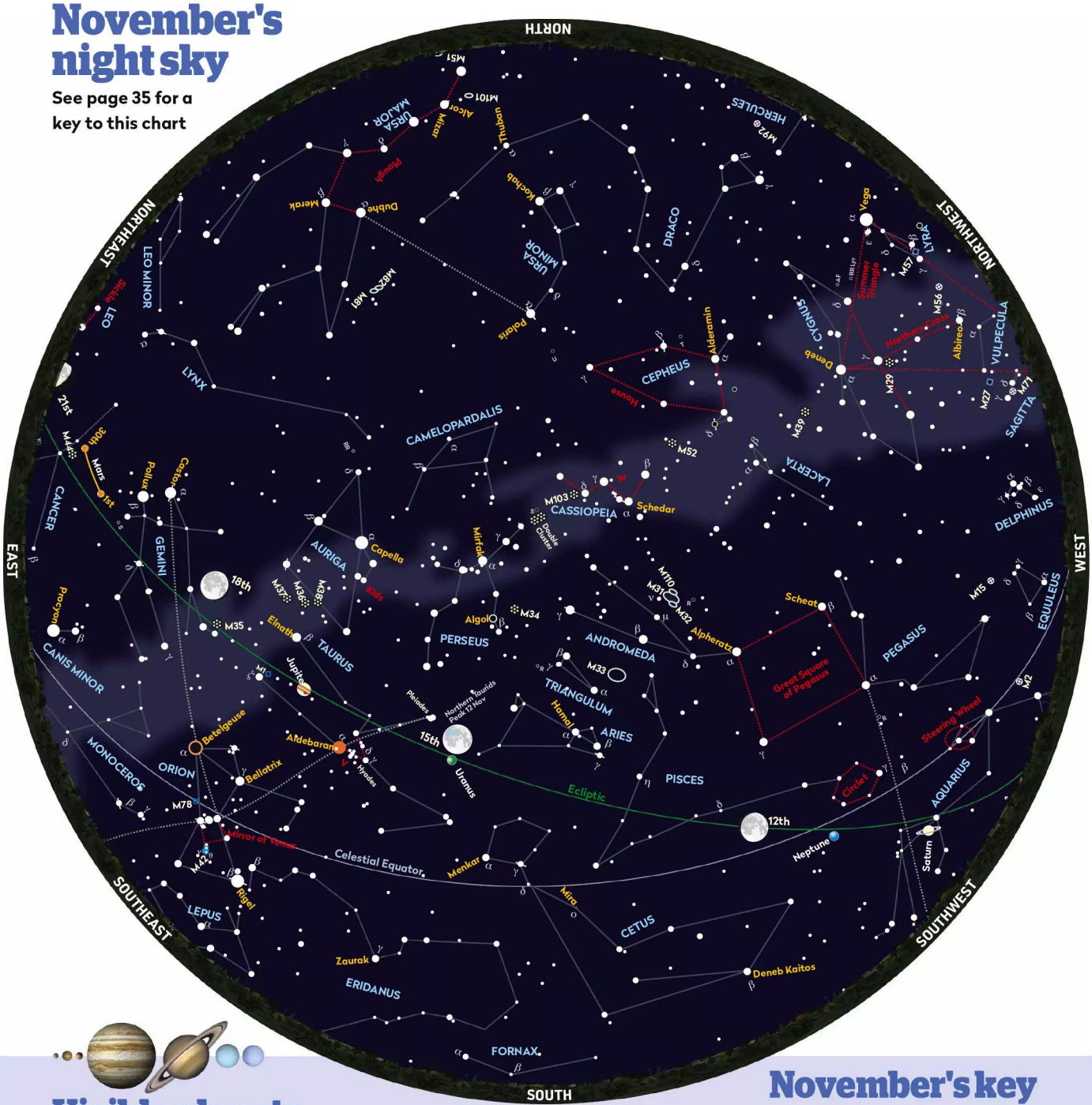
A binocular sweep through the misshapen pentagon of Auriga reveals interesting clusters, including a grand trio of Messiers: **M38** to the north, **M37** to the south and **M36** in between. In particular, looking at M38 through binoculars reveals another interesting pattern, the **Cheshire Cat asterism**. This looks like a smiling mouth with two stars marking the cat's eyes. M38 sits at the northern corner of the mouth.

The Messier trio of M36, M37 and M38 in Auriga, the latter marking the position of the Cheshire Cat asterism

PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

November's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Evening planet, reaches greatest eastern elongation on 15 November. Not ideally placed.

Venus
Improving evening planet, setting nearly three hours after the Sun at the end of November.

Mars
Well-placed planet. Located 2° from M44 end of month.

Jupiter
Approaching opposition and well presented in Taurus.

Saturn
Well-presented evening planet in Aquarius.

Uranus
Opposition on 17 November and beautifully presented all month long.

Neptune
Well-positioned evening planet which reaches peak altitude of 35° in darkness all month.

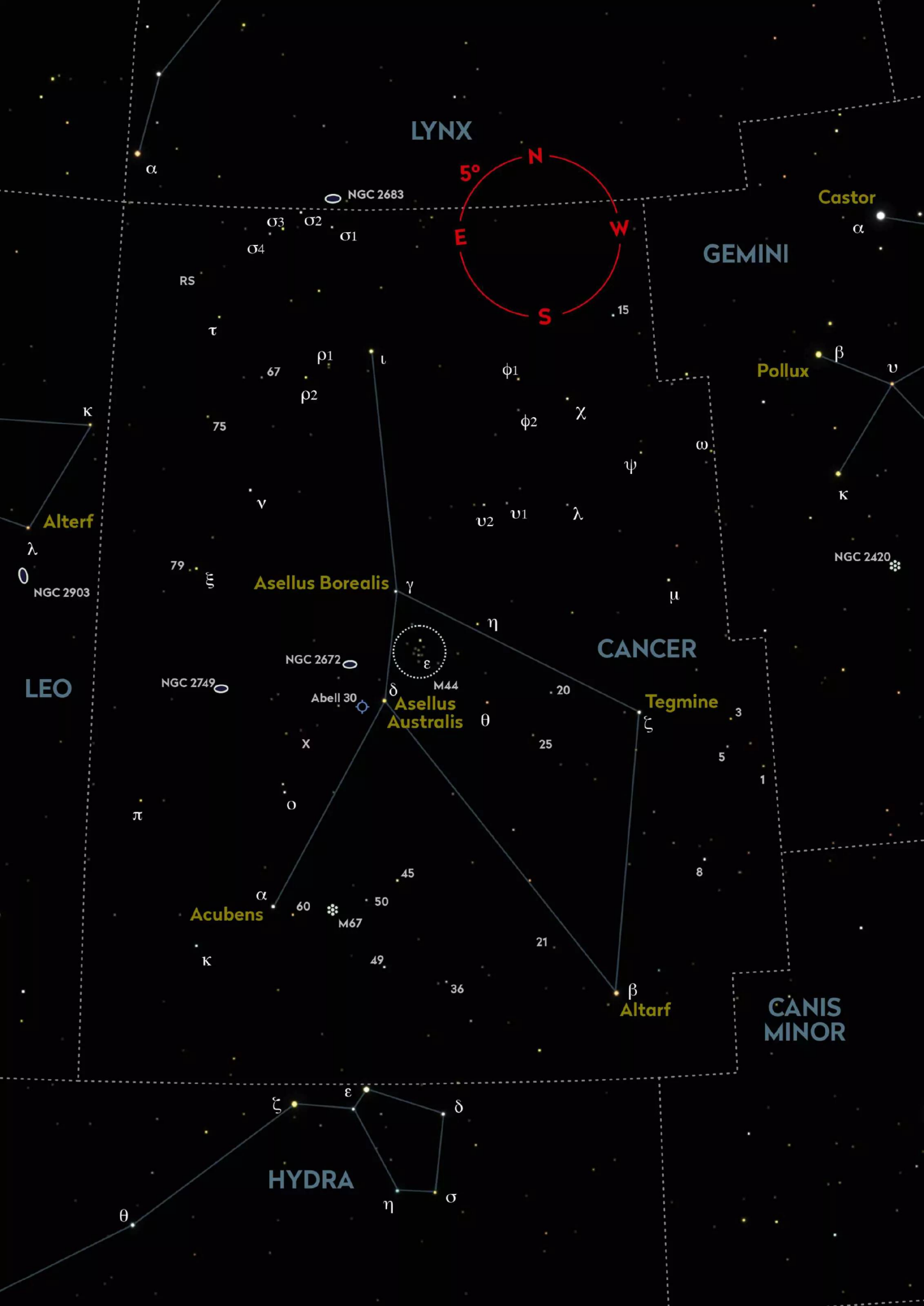
November's key Moon phases

NEW MOON
1 Nov

FIRST QUARTER
9 Nov

FULL MOON
15 Nov

LAST QUARTER
23 Nov


LYNX
5°
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NGC 2683
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15
Castor
α
GEMINI
ρ1
ι
67
ρ2
φ1
Pollux
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75
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λ
Alterf
λ
79
ξ
Asellus Borealis
γ
NGC 2903
NGC 2420
μ
η
CANCER
NGC 2672
ε
LEO
NGC 2749
M44
δ
20
Abell 30
Asellus Australis
θ
Tegmine
ζ
3
X
25
5
1
ο
π
45
8
α
Acubens
60
50
M67
21
κ
49
36
β
Altarf
CANIS MINOR
ε
ζ
δ
HYDRA
η
σ
θ

Constellation of the season

WINTER: Cancer

Cancer represents a mythological giant crab which lived in the lagoon of Lerna, a region in southern Greece rich in springs and lakes. The creature was instructed by Hera to attack Hercules while he battled the Hydra of Lerna during one of his 12 labours. Hercules despatched the crab by stamping on it. Hera placed it amongst the stars in gratitude for its efforts.

Visually, the constellation of Cancer doesn't immediately stand out. It nestles between Gemini, the Twins to the west and Leo, the Lion to the east. Locate it by imagining the mid-point between bright Castor (Alpha (α) Geminorum) and Regulus (Alpha (α) Leonis), which brings you right to the heart of the Crab.

Cancer is formed by dim stars arranged like an inverted 'Y'. The north point (the base of the Y) is marked by double star Iota (ι) Cancri, the two southern markers being Acubens (Alpha (α) Cancri) in the southeast and Altarf (Beta (β) Cancri) in the southwest. The point where the top of the letter joins its stem is marked by Asellus Australis (Delta (δ) Cancri). Of these, mag. +3.5 Altarf is brightest, then it's mag. +3.9 Asellus Australis, +4.0 Iota and, despite its alpha designation, mag. +4.3 Acubens is dimmest.

Messier objects

Asellus Australis marks the southeast corner of a small box pattern with mag. +4.7 Asellus Borealis in the northeast, Eta (η) and Theta (θ) Cancri in the northwest and southwest respectively, both mag. +5.3 stars. Cancer's most famous object is the winter showpiece open cluster M44, which sits inside this box pattern. M44 is known as the Beehive Cluster because, with binoculars, the many bright stars near the cluster's centre appear like bees swarming around a triangular roofed hive. M44 is also known as Praesepe, which means 'crib' or 'manger'. The two eastern stars in the box that surrounds M44 are Asellus Australis and Borealis; the Southern and Northern Donkey which are supposed to be eating from the manger. At a distance of 610 lightyears, M44 is one of the closest open clusters and appears to the naked eye as a mag. +3.7 smudge, although under poor conditions the cluster can't be seen without assistance. Lying 1.3° north of the Ecliptic, M44 is regularly visited by the Moon and planets.

Despite being the 31st constellation by area and rather faint, Cancer has two Messier objects. The second is open cluster M67 near Acubens. This is known as the King Cobra or Golden Eye Cluster and is estimated to be between 2.6 and 2.9 thousand lightyears away. Its apparent magnitude is +6.1 and it requires optical assistance to see well. M67 appears half-a-degree across and densely concentrated, categorised as Trumpler class II2r. It's an ancient cluster, estimated at 3.2-5.0 billion years of age. M44 by comparison is believed to be between 600-700 million years old.

Switching to the north of Cancer brings us to Iota Cancri. Located 1.3° east-southeast of Iota is mag. +5.9 Rho^1 Cancri, with mag. +5.2 Rho^2 0.8° further east-southeast. Rho^1 has a mag. +6.3 star 4.5 arcminutes south of it, visible using binoculars. Rho^1 is also known as 55 Cancri and lies at a distance of 41 lightyears. It's a binary with a K-type primary (55 Cancri A) and a red dwarf secondary (55 Cancri B). The primary is known to have 5 extrasolar planets in orbit around it, 55 Cancri b, c, d, e and f, which carry the names Galileo, Brahe, Lipperhey, Janssen and Harriot respectively.

▼ Left: M67 is a rich open cluster located near Acubens (Alpha (α) Cancri)

Right: Being close to the Ecliptic, M44, the Beehive Cluster, is frequently visited by Solar System objects, such as Mars, seen here.

ALL PICTURES: PETE LAWRENCE

December

Don't miss the shadow transits of Ganymede and Titan, and the lunar occultation of Mars

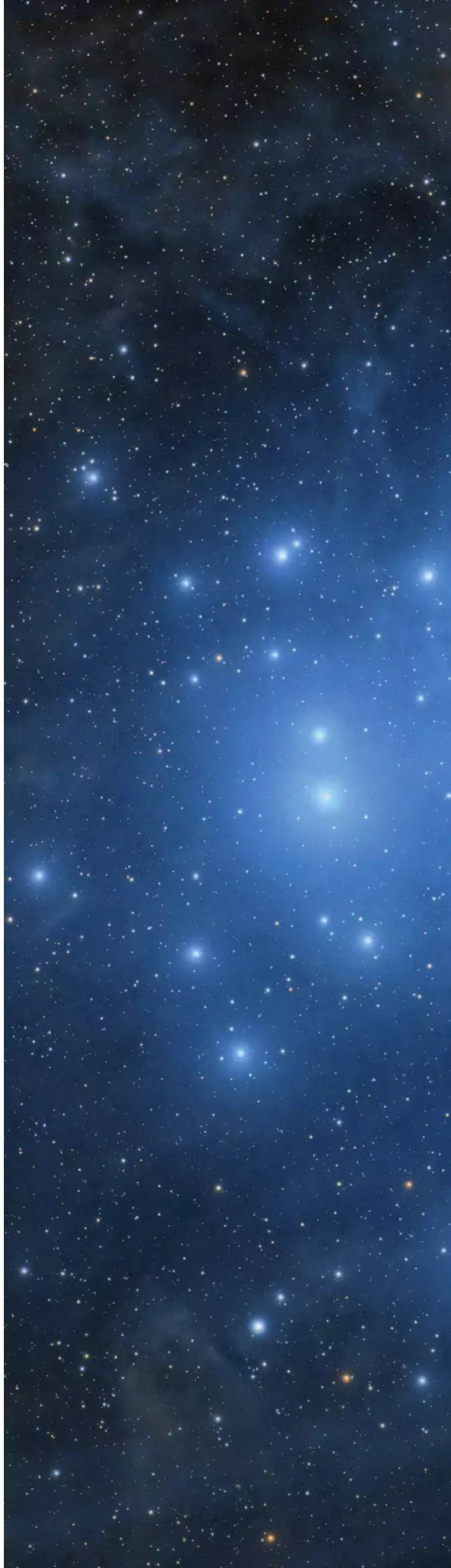
6 December Titan shadow transit on Saturn from 18:32 UT (pm)

7 December Jupiter reaches opposition in Taurus

8/9 December Excellent Ganymede shadow transit on Jupiter from 22:30 UT

18 December Daylight lunar occultation of Mars (am)

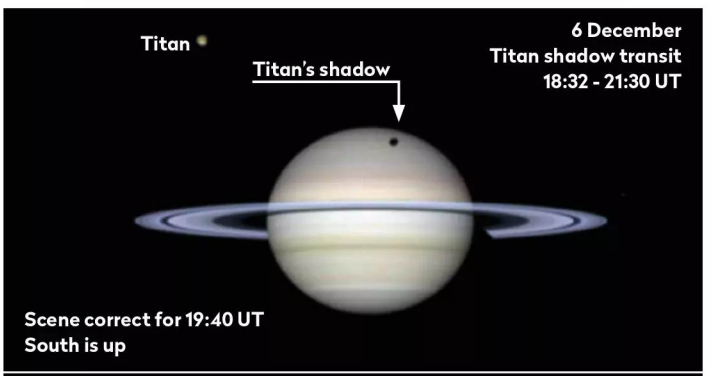
22 December Ursid meteor shower peak (am)

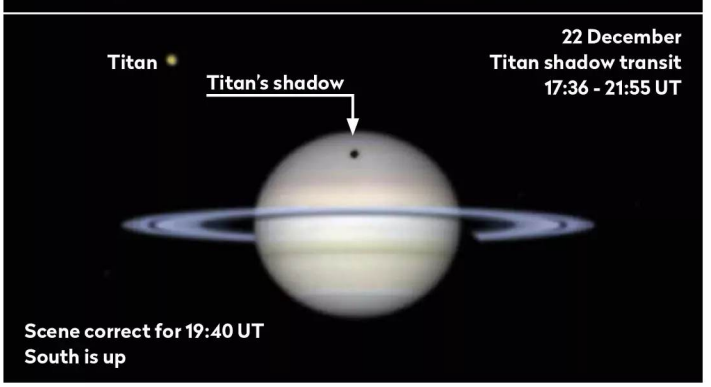


The Pleiades ▷

Ronald Brecher, Guelph, Ontario, Canada, 6 December 2020–9 February 2021

December at a glance





▲ Two excellent Titan shadow transits are visible from the UK this month

In stark contrast to the beginning of the year, all main planets are now well-presented, even **Mercury** in the morning sky at the end of December. **Jupiter** reaches opposition on 7 December and appears to shine at mag. –2.7 among the stars of Taurus, the Bull. At opposition its four largest moons appear to cross the planet's disc in sync with their shadows. A good example occurs on the night of 8 December into the morning of 9 December (22:30 UT - 00:54 UT) when **Ganymede** appears to touch its own shadow as it transits Jupiter's disc.

Another impressive event occurs on 18 December. **Mars** is now bright and prominent in the night sky ahead of its own opposition towards the end of January 2025. Shining at mag. –0.9 in the early hours of 18 December, a 90%-lit waning crescent Moon appears to approach the planet as dawn arrives. Later, after sunrise a rare **lunar occultation** of Mars occurs which, despite it being daylight, should still be observable thanks to the planet's elevated brightness.

The full Moon on 15 December spells bad news for the rich **Geminid meteor shower**. Predicted to reach maximum activity at 02:00 UT on 14 December, the entire night of 13/14 December will have a virtually full Moon riding high across the night sky from dusk until dawn, severely diminishing the number of Geminids seen. The lower rate **Ursid meteor shower** is predicted to peak at 10:00 UT on 22 December, but even this can't escape the poorly timed last quarter Moon, which will interfere with the optimum period in the early hours of the 22nd.

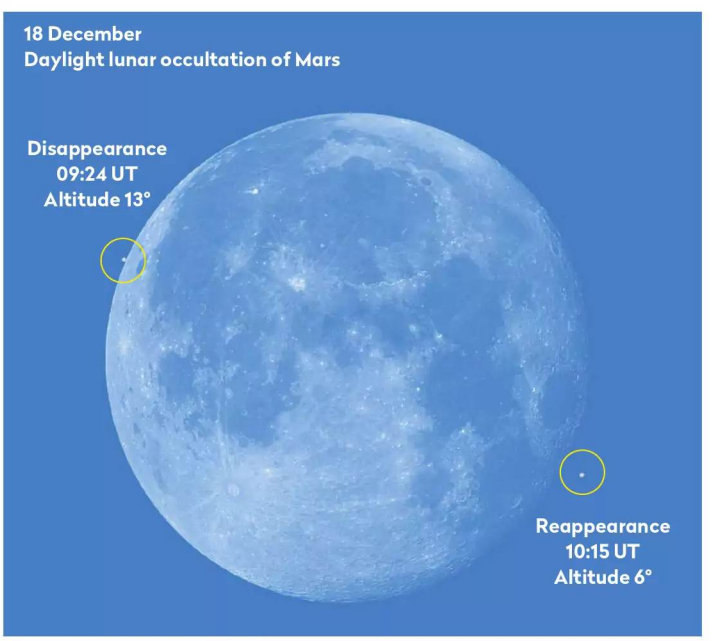
The long December night offers some excellent stars and constellations to explore. We've now come full circle in terms of what's visible. **Orion, the Hunter** is appearing centre stage once again. The winter **Milky Way** flows north-south to the east of Orion, a shadow of its bright summer counterpart. This is because here we are looking away from our Galaxy's core. Despite this, there are plenty of 'local' deep sky objects in this region to explore.

Follow the line of Orion's Belt southeast to bright **Sirius** (Alpha (α) Canis Majoris), the **Dog Star**. Head northeast (up and left from the UK) from Sirius to another bright star with little around it. This is **Procyon** (Alpha (α) Canis Minoris) the brightest star in Canis Minor, the **Little Dog**. Join the dots between Procyon, Sirius and Betelgeuse (Alpha (α) Orionis) in Orion's northeast corner to find the **Winter Triangle** asterism.

The winter Milky Way flows through the Winter Triangle, a space occupied by the dim constellation **Monoceros, the Unicorn**. Here lie many deep sky wonders including the **Rosette Nebula**, the **Cone Nebula** and, fittingly for this time of year, the **Christmas Tree Cluster** – both of the latter are confusingly designated NGC 2264.

As Sirius moves into its highest position due south, look south of the star for open cluster **M41**. Sirius is so bright because it's close at a distance of 8.6 lightyears – its light passing through the turbulent atmosphere close to the horizon, causing it to flicker and flash bright colours.

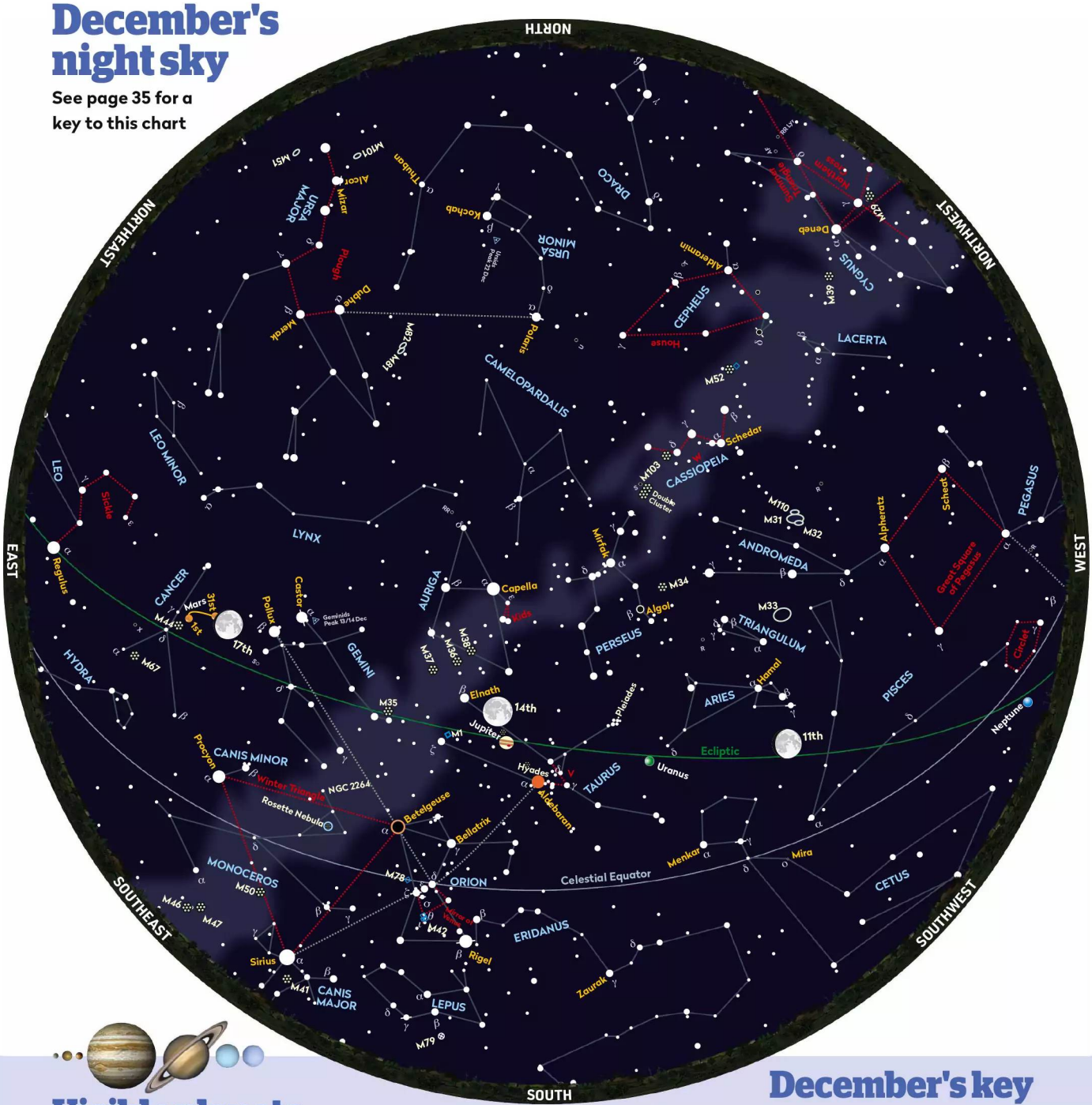
▼ Mars will be occulted by the Moon in daylight on 18 December



PETE LAWRENCE X 3, ISTOCK X 7, NASA X 4

December's night sky

See page 35 for a key to this chart



Visible planets

Where to spot the planets this month

Mercury
Inferior conjunction on 6 December. Excellent morning planet at end of December.

Venus
Excellent position in the evening sky, setting over four hours after sunset by the end of December.

Mars
Excellent planet approaching opposition next month. Daylight occultation by Moon on 18 December.

Jupiter
Opposition on 7 December. Gets to 60° peak UK altitude in dark skies all month.

Saturn
Well placed at the start of December.

Uranus
Well-placed evening planet.

Neptune
Well-placed binocular planet for most of December.

December's key Moon phases

NEW MOON 1 Dec
FIRST QUARTER 8 Dec
FULL MOON 15 Dec
LAST QUARTER 22 Dec
NEW MOON 30 Dec

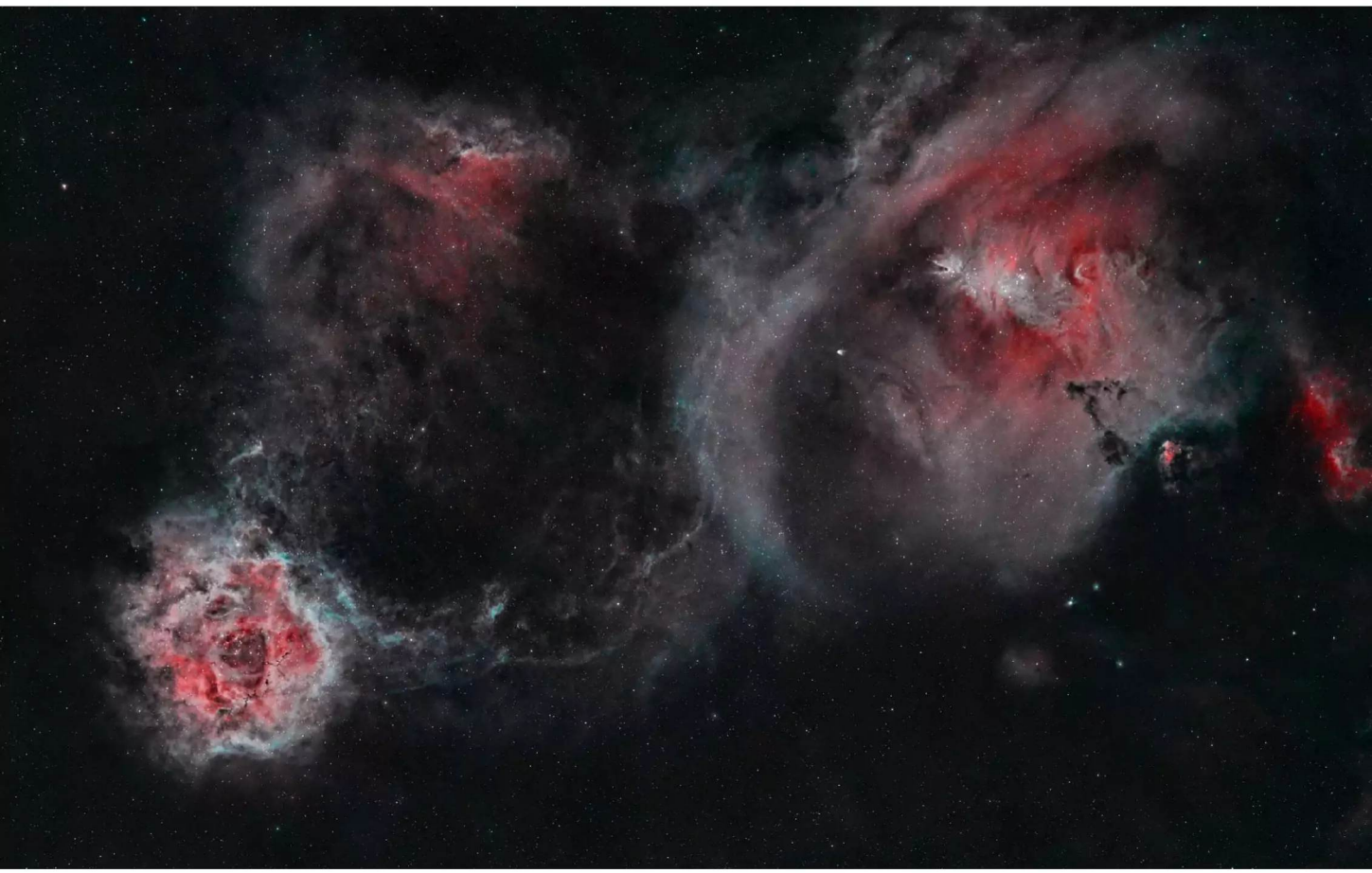
NGC 7293, the Helix Nebula

Daniel Stern, remotely via DeepSkyChile, Rio Hurtado, Chile, 5, 7, 13, 14 and 15 June 2023

BBC Sky at Night MAGAZINE

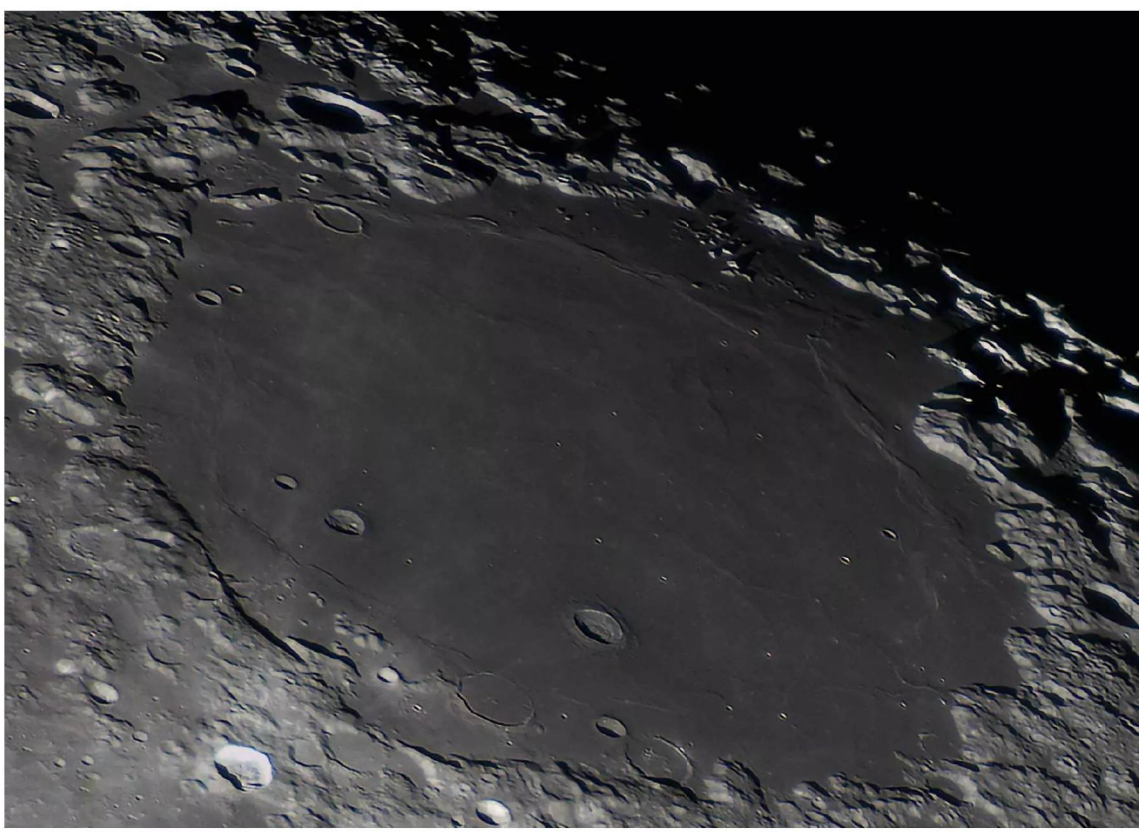
Gallery WINNERS

Winning images from *BBC Sky at Night Magazine*'s monthly astrophotography competition in 2023



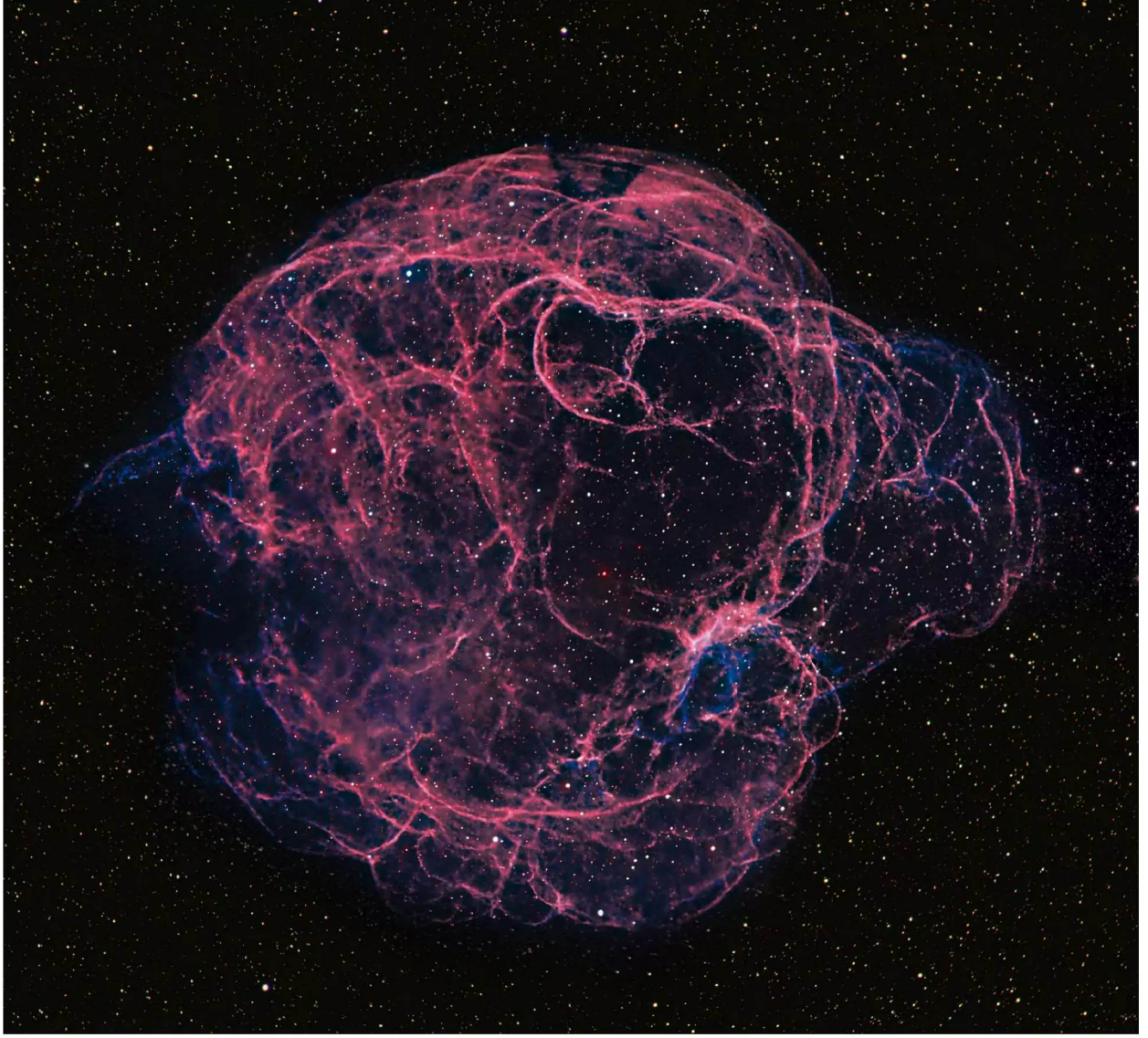
△ The Rosette Nebula and the Cone Nebula

Tim Barry,
Milton Keynes,
Buckinghamshire,
6, 7, 13 and
26 February 2023



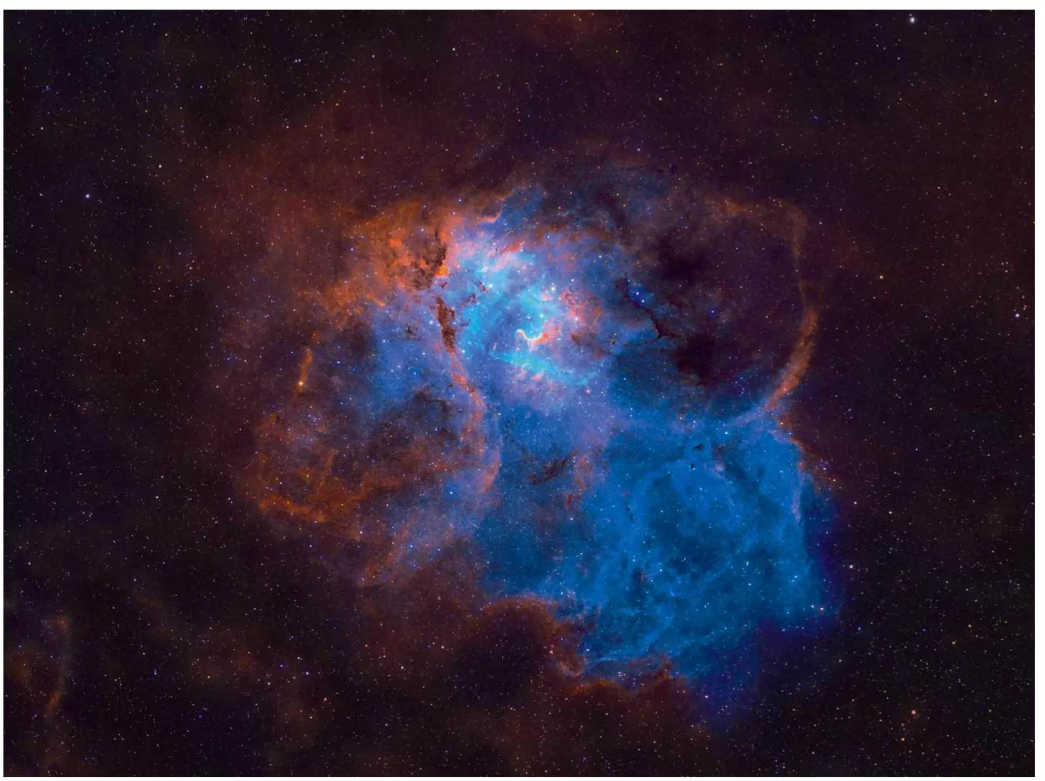
Mare Crisium ▷

Kevin Earp,
Willington,
Bedfordshire,
10 December 2022



△ The Spaghetti Nebula

Michael P Caligiuri, Anza Borrego Desert, California, 25–26 November 2022

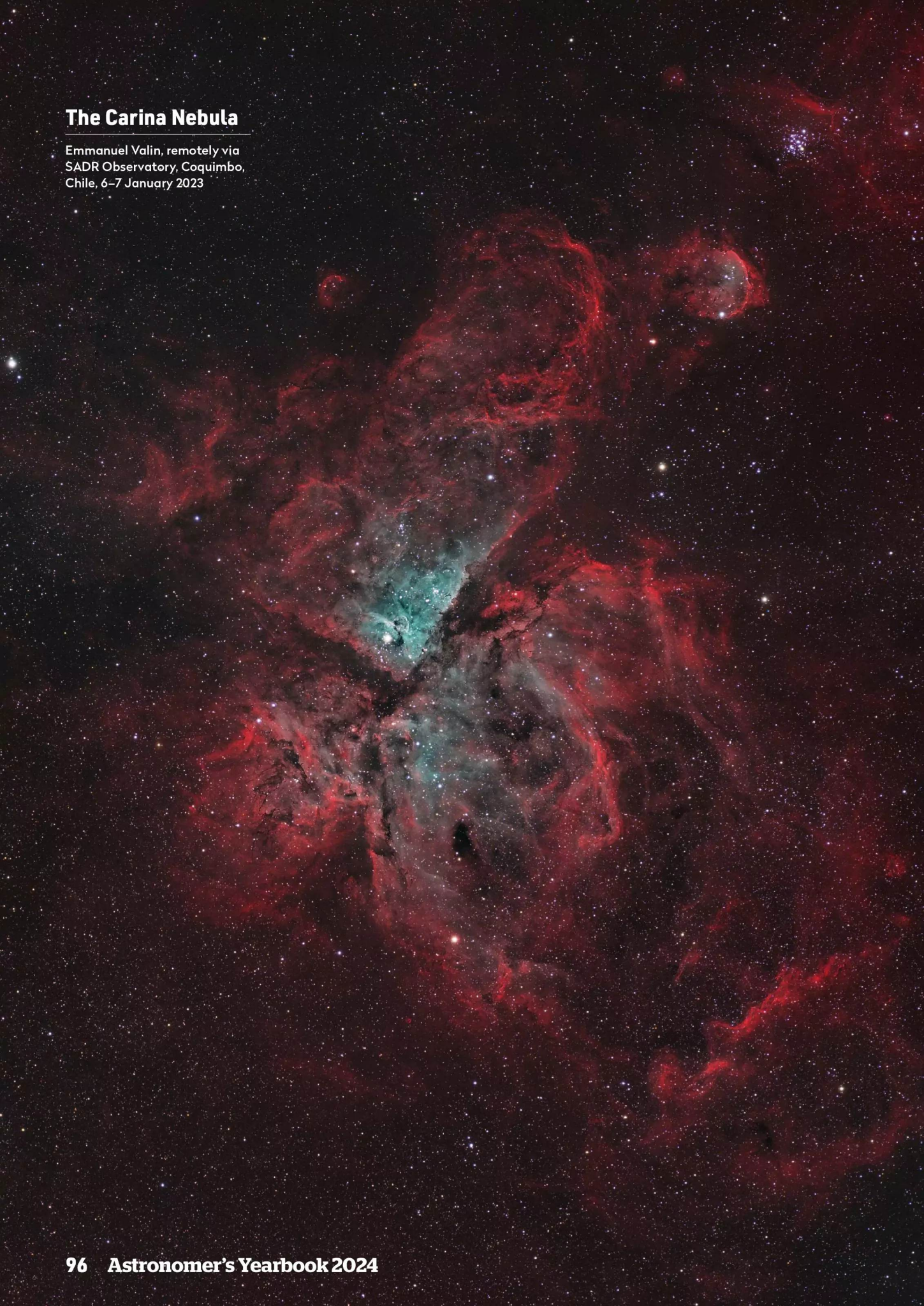


The Lion Nebula ▷

Daniel Hightower, Hardeeville, South Carolina, USA, 15–20 October 2022

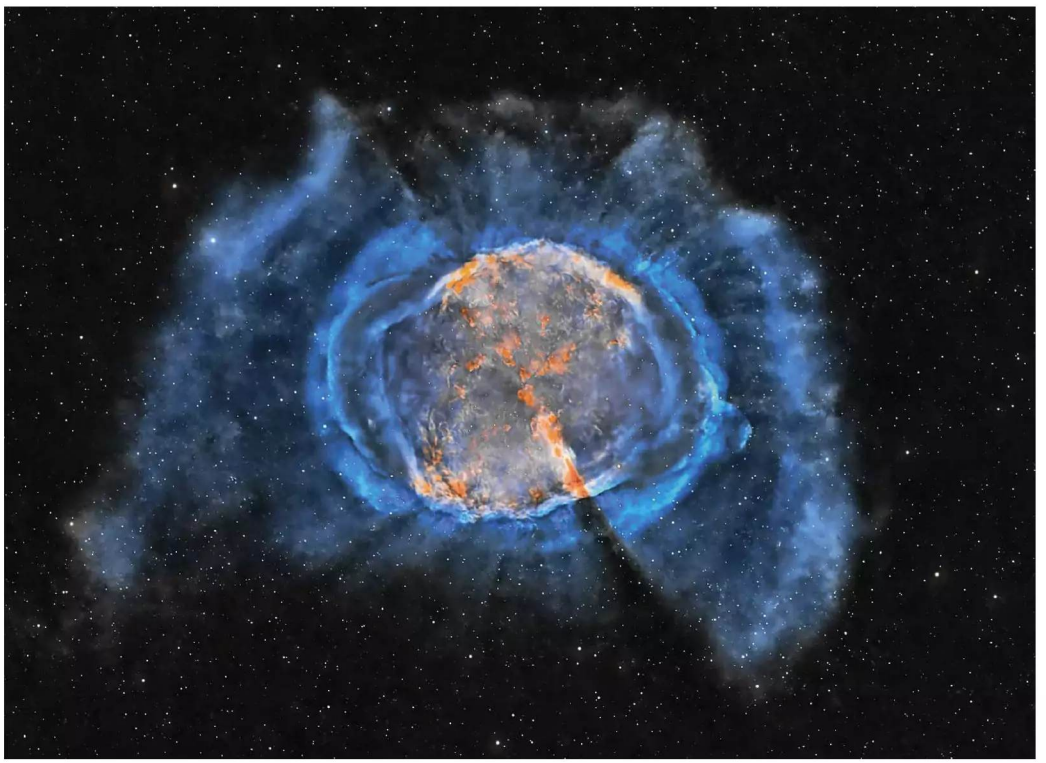
The Elephant's Trunk Nebula

Vikas Chander, Animas, New Mexico, USA, 15–23 July 2023



The Carina Nebula

Emmanuel Valin, remotely via SADR Observatory, Coquimbo, Chile, 6–7 January 2023

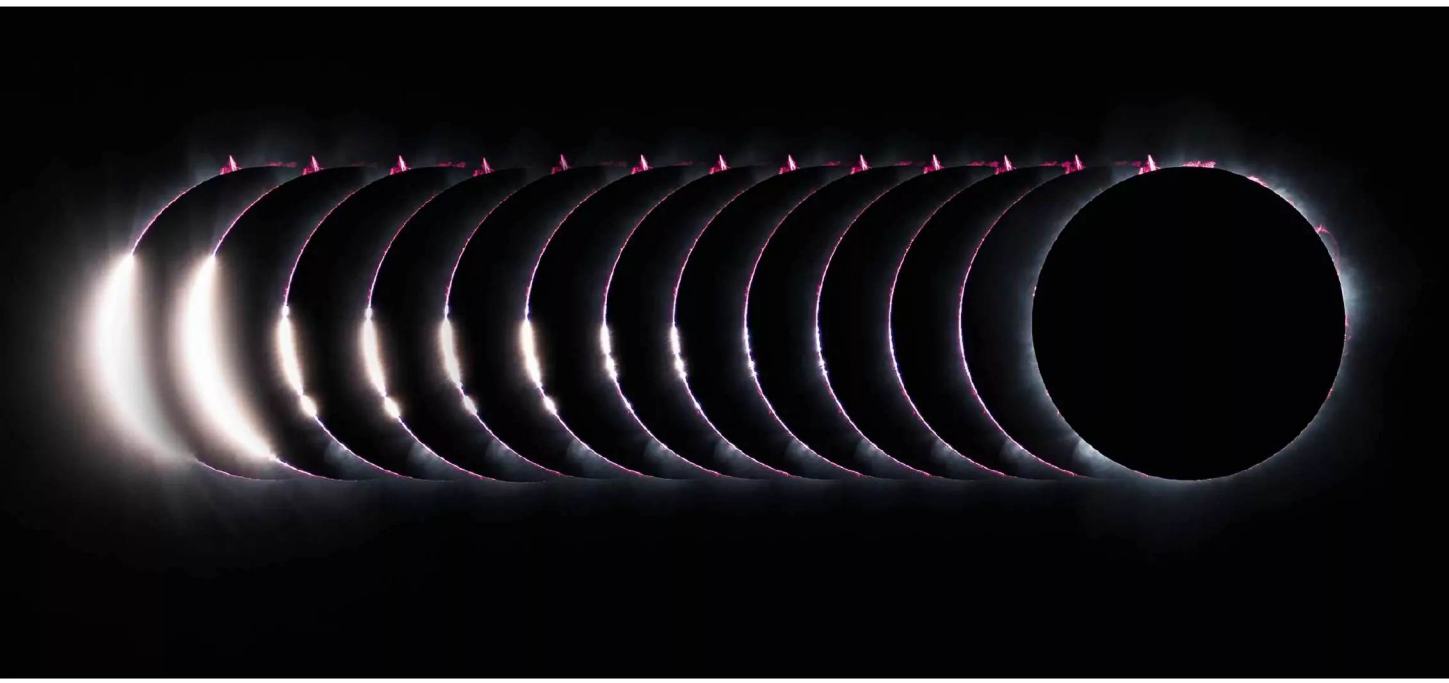


◁ M27, the Dumbbell Nebula

Patrick Cosgrove, Honeoye Falls, New York, USA, 2–4 August 2021

▽ Comet C/2022 E3 ZTF

Tim Jackson, Cheltenham, Gloucestershire, 24 January 2023

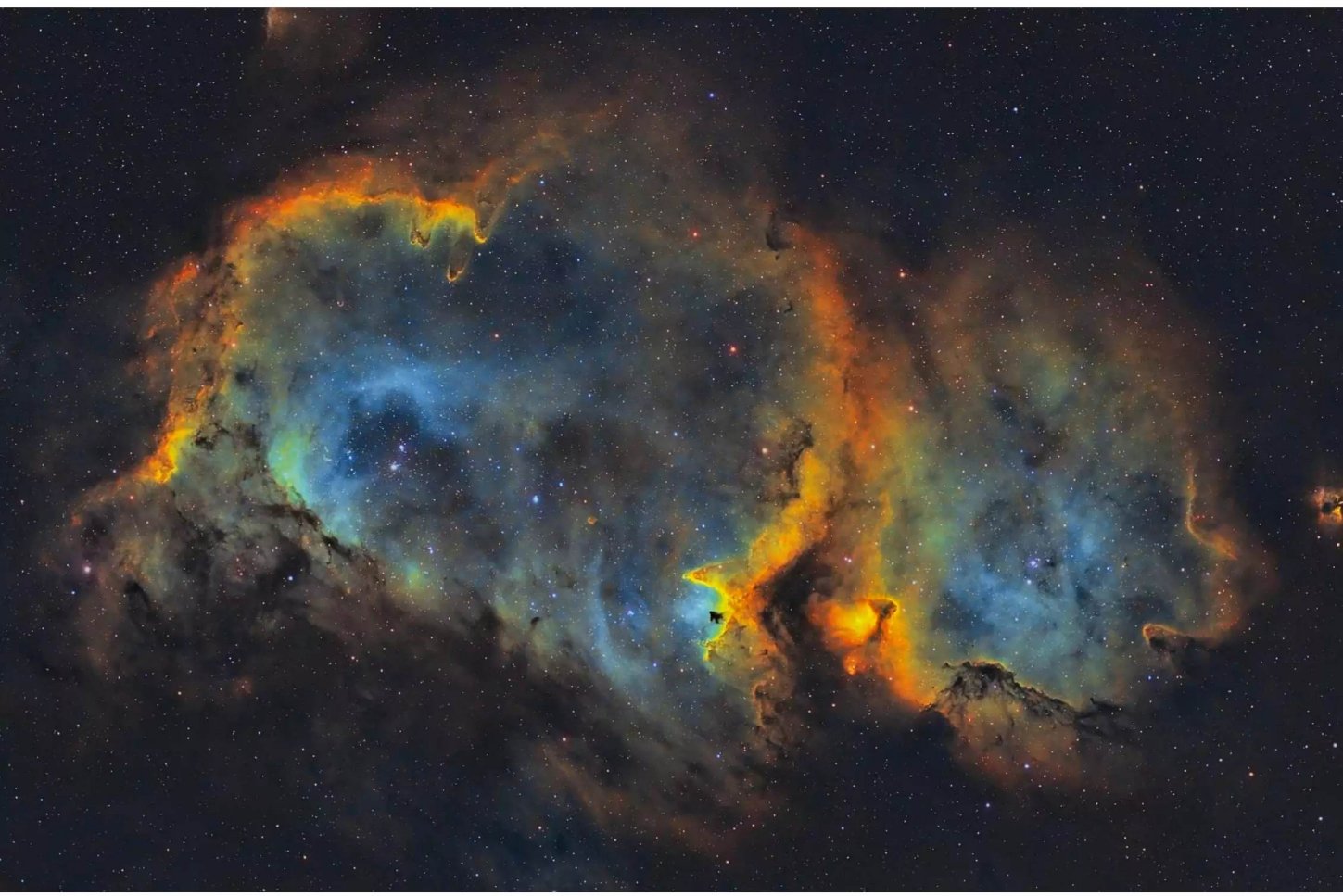


△ Solar eclipse

Chirag Upreti, South Lefroy Bay, Western Australia, 20 April 2023

▽ The Soul Nebula

Giuseppe De Pace, Turin, Italy, July – August 2023



M8, the Lagoon Nebula and M20, the Trifid Nebula

Antoine and Dalia Grelin, captured remotely via Utah Desert Remote Observatories, Utah, USA, 1-2 August 2023

Project 1: Tracking a comet

Here is how to follow C/2023 A3 Tsuchinshan, a potential naked eye comet for 2024

▲ Comet C/2023 A3 will be closest to Earth on 12 October when it passes our planet by 70.7 million km. It could look spectacular as shown on the left, or less impressive as shown on the right. Only time will tell...

The arrival of a naked eye comet is an event which is fleetingly rare. Therefore the announcement that such an occurrence could happen for early autumn 2024 was something which raised considerable excitement. Here, we look at C/2023 A3 Tsuchinshan-ATLAS and predict how it may perform and be seen from the UK throughout 2024.

C/2023 A3 as we'll refer to it, is an Oort cloud comet discovered on 9 January 2023 at the Purple Mountain Observatory in the east of Nanjing, China and independently on 22 February 2023 by the Asteroid Terrestrial-Impact Last Alert System (ATLAS) at the Sutherland Observatory in South Africa. It's an exciting object due to pass 0.39 AU or 58 million km from the Sun on 27 September 2024. It's expected to be above the naked-eye threshold from late August through to early September 2024.

January-March

At the start of 2024, C/2023 A3 is in Libra. Initially heading east, its motion reverses direction after the first week in February, thereafter tracking west and slightly north as it passes into Virgo late March. C/2023 A3 is expected to brighten from mag. +14.5 on 1 January to +11.6 by 31 March. It is reasonably located for the UK over this period, a moderate-sized telescope allowing the comet to be tracked under dark sky conditions.

▼ The path of C/2023 A3, 1 January to 19 June. The comet is visible from the UK January to May, but lost in the bright June sky. Predictions show an increase from mag. +14.5 to +8.8

April-June

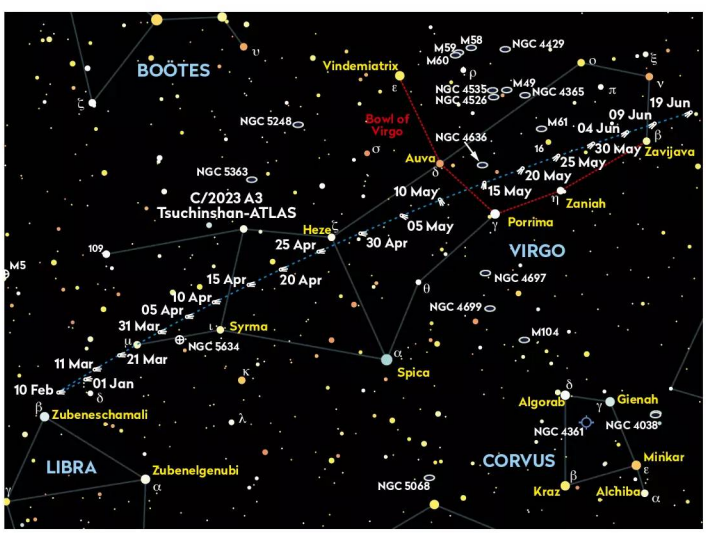
From 1 April to 12 May, the comet remains well placed under dark skies as it trundles west through Virgo. The Moon interferes after 12 May, but with luck it should still be possible to follow the comet through to the end of May. C/2023 A3's brightness is expected to increase from +11.5 on 1 April, through to +9.0 by the end of June. The comet is unlikely to be visible during June due to the lack of dark skies near the June solstice.

July-August

The first part of summer doesn't favour C/2023 A3. Located in southeast Leo and passing into Sextans in the second week of August, the comet appears close to the Sun. Unless something unexpectedly dramatic occurs, C/2023 A3 is unlikely to be seen from the UK over this period.

September-October

C/2023 A3 reaches perihelion on 27 September, passing the Sun by 58 million km. Its brightness is expected to increase from mag. +5.0 to mag. +0.3 or possibly even brighter. Towards the end of September, C/2023 A3 is in Sextans with the Sun in Virgo, 25° east of the comet. It should be possible to see C/2023 A3 under moderately deep twilight in the early morning and, if it approaches mag. 0.0, it should certainly be visible. During October, C/2023 A3 sprints east through



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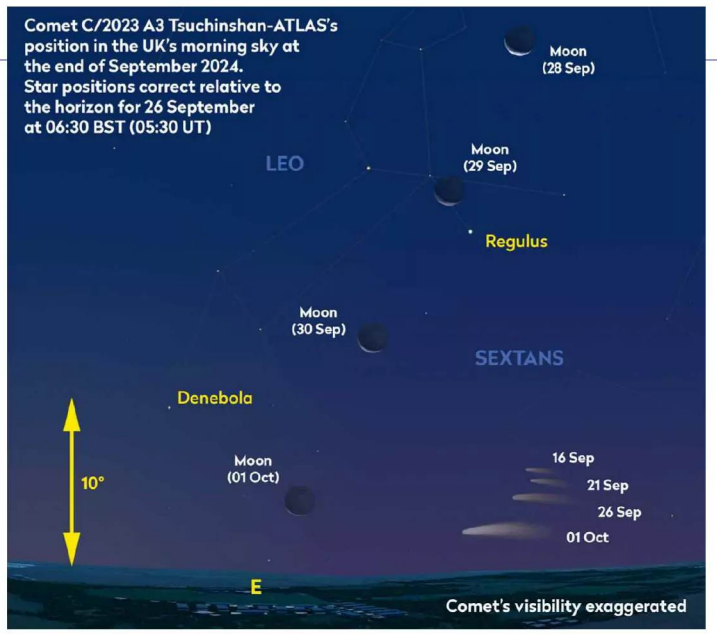


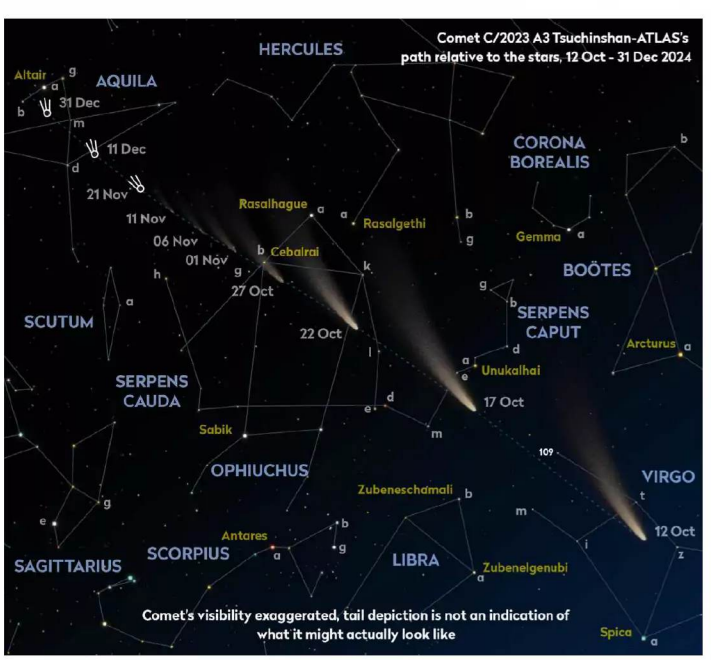
Leo, Virgo and Serpens Caput, ending the month in Ophiuchus. Its magnitude is expected to vary from +0.3 in early October to +4.3 by 31 October, still above the naked-eye threshold. Its apparent path takes it back past the Sun, but careful planning will allow some decent views over this period. Certainly, towards the end of October, there is plenty of opportunity to see comet under dark sky conditions.

▲ The period around perihelion for C/2023 A3 give tricky, but not impossible, viewing circumstances from the UK

November-December

For the remainder of the year, C/2023 A3 continues moving east, curving northeast through December. It starts its November track in Ophiuchus near Cebalrai (Beta (β) Ophiuchi), moving east through northern Serpens Cauda before ending the year in Aquila. Its magnitude is expected to drop from +4.4 at the start of November to around +11.2 by 31 December.

▼ The best viewing opportunities for C/2023 A3 from the UK are during October, in the evening sky after sunset



How bright will it get?

A comet's brightness is determined by its activity, absolute magnitude, distance from the Sun and distance from Earth.

A standard formula is used to predict comet brightness, but this requires observed magnitude estimates in order to resolve unknowns in the formula. Once done, the formula is used to generate a brightness curve giving a reasonable prediction of brightness versus date. Based on observed values for C/2023 A3, its peak magnitude is expected to be between mag. +0.7 and +0.3. However, other factors can come into play, especially when perihelion distance is fairly small.

An effect called 'forward scattering' occurs when particles in the comet's dust tail scatter sunlight towards the observer, increasing the comet's overall brightness. Early predictions incorporating forward scattering suggest a magnitude –3.5 peak. This level might make it possible to observe the brightest part of C/2023 A3 during daylight, as happened with comet C/2006 P1 McNaught in 2007.

Second is the unpredictability of an Oort cloud comet moving close to the Sun. Will activity follow expectations, increase or fizzle out? Will the comet even survive perihelion? The much-hyped comet C/2012 S1 ISON had been predicted to become the 'comet of the century' back in 2013. But passing 1.8 million km from the Sun on 28 November 2013, it almost completely disintegrated and was barely visible when re-emerging from the Sun's glare.

Then there was comet C/1975 V1 West, which passed 29.5 million km from the Sun on 25 February 1976. Its nucleus fragmented into four pieces post perihelion, which increased the comet's dust production. Aided by forward scattering, comet West brightened to a peak magnitude of –3.0 and was observed during daylight from 25-27 February 1976.

What will happen with C/2023 A3? We honestly don't know, but that is part of the joy of observing comets. Making magnitude estimates and noting changes in appearance could provide the crucial information for predicting just what we'll finally see in the early autumn of 2024.

How did you do?

How many observations of C/2023 A3 were you able to make? How did the reality compare to prediction?

Project 2: Observing open clusters

In this project we're encouraging you to spot many different open cluster types

◀ M35 in Gemini has a Trumpler classification of III,3,r. The more concentrated NGC 2158 in the lower-right was once thought to be a globular, but has been reclassified as an open cluster with Trumpler classification II,3,r

Most people have seen an open cluster. The bright ones such as the Pleiades or V-shaped Hyades in Taurus are obvious, but others can be more subtle. Consider Orion's Belt, for example. When you look at the three Belt stars, you're looking into the heart of open cluster Collinder 70. The three examples given so far are large with bright elements, and easy to see with the naked eye. However, most aren't, and require a bit, or a lot, of optical assistance to see. Here, we look at open clusters in general, hopefully encouraging you to gain a wider perspective on the various types that are visible.

▼ Examples of clusters for each Trumpler class, ignoring variations due to nebulosity (N suffix). Note Cr is the abbreviated form of Collinder

I: Dense	Richness		
Brightness range	p	m	r
1	NGC 6425 (Sco)	M26 (Scu)	M37 (Aur)
2	M25 (Sgr)	M48 (Hyd)	M11 (Scu)
3	NGC 7160 (Cep)	M47 (Pup)	M41 (CMa)

II: Mid-dense	Richness		
Brightness range	p	m	r
1	IC 1434 (Lac)	NGC 1531 (Per)	NGC 6939 (Cep)
2	NGC 2343 (Mon)	NGC 2266 (Gem)	M38 (Aur)
3	NGC 2244 (Mon)	M44 (Cnc)	M45 (Tau)

III: Mid-sparse	Richness		
Brightness range	p	m	r
1	NGC 7063 (Cyg)	Stock 2 (Cas)	NGC 6811 (Cyg)
2	IC 4665 (Oph)	NGC 6633 (Oph)	NGC 6940 (Vul)
3	M18 (Sgr)	NGC 2265 (Mon)	M35 (Gem)

IV: Sparse	Richness		
Brightness range	p	m	r
1	NGC 743 (Cas)	NGC 2482 (Pup)	Cr 110 (Mon)
2	Cr 419 (Cyg)	NGC 2395 (Gem)	NGC 1817 (Tau)
3	Cr 97 (Mon)	NGC 6507 (Sgr)	NGC 2232 (Mon)

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Let's start by looking at what an open cluster actually is. Stars form when clouds of hydrogen gas collapse. If there's enough matter in the cloud, eventually nuclear fusion will occur within the extreme conditions at the heart of the collapse. The energy released from this process counteracts the cloud's gravitational collapse. Eventually, an object is created which is in physical equilibrium while radiating energy; a star. If the cloud is large, many stars may form together, resulting in an open cluster.

A young cluster typically contains hot blue stars, tightly contained in a relatively small volume. Over time, gravitational forces cause heavier stars to migrate inward, while the lighter members move out – a process called 'mass segregation'. The population of an aging cluster starts to yellow as its stars evolve. Eventually, the cluster will contain many orange-red stars.

Cluster types

Open clusters come in many types. Some appear surrounded by the unused primordial gas from which they formed – this type of cluster is described as embedded. The Trapezium Cluster in the heart of the Orion Nebula, M42, is an example of an embedded cluster, the ionizing light from the stars exciting the gaseous material around the cluster to produce the emission nebula we know as M42.

Others, such as the Pleiades, appear enveloped in gaseous strands which are very evident in long exposure photographs. Originally this was thought to be the remnants of the cloud from which the Pleiades formed. However, it's now believed to be a chance interaction, the cluster stars passing through two huge dust clouds, each with its own motion characteristics. The Pleiades nebula appears blue due to the dust scattering the light from the hot, young Pleiads, to form what's known as a reflection nebula.

Open clusters form within the galactic plane of their host galaxy. Consequently, there are many visible in the winter and summer night sky, but less in the autumn and spring. During summer and winter, the Milky Way

orientates so its star-populated disc is optimally presented at night. In spring and autumn, we peer out at right angles to the plane of this disc, into deep space beyond the Milky Way.

While we mention the Milky Way, it's worth pointing out that there is another type of cluster known as a globular, which is distinct from an open cluster. Globulars surround the core of their host galaxy in a halo arrangement. Individually, they comprise a vast number of stars, gravitationally bound in a spheroidal volume. Each member star is in mutual orbit around a common centre of mass.

There are over a thousand known open clusters in our Galaxy and it's probably of no surprise that classification schemes have arisen to categorise them. The most popular was introduced by Robert Trumpler in 1930 and categorises clusters according to three criteria; concentration, brightness range and richness.

Open clusters vary from being very dense to very sparse. On the Trumpler scheme this is indicated by 4 concentration classes indicated by a Roman numeral I-IV, I being dense, IV sparse. Brightness range refers to the member stars and is indicated by one of three values; 1 indicating stars of similar brightness, 2 indicating a moderate range in brightness and 3 indicating a complete mix of bright and faint stars. Finally, richness is indicated by a letter; p for poor (less than 50 members), m for medium-rich (50-100 members) and r for rich (more than 100 members). A further suffix, 'N', is appended to the classification if there is nebulosity associated with the cluster. See some examples in the table (left).

▲ The famous Beehive Cluster, M44, in Cancer has a Trumpler classification of II,3,m

Locating Trumpler class information isn't always easy, but there are catalogues which show the information available online (for example **https://adsabs.harvard.edu/full/1966BAICz..17...33R**). It's worth noting that there's been a certain amount of subjectivity regarding classifications in the past, for example the open cluster M25 in Sagittarius has been listed by different sources as I,2,p, I,3,m and IV,3,r – which is quite a wide range!

Using the Trumpler classification scheme, see how many open cluster of different classification types you can find, observe, sketch or photograph, and build a library of objects to illustrate the different types. This is a long-term project, which will hopefully give you even more reason to investigate and study these beautiful objects. As ever, when you do record one, make sure you date and timestamp your observation, as well as documenting the equipment you used to observe it.

How did you do?

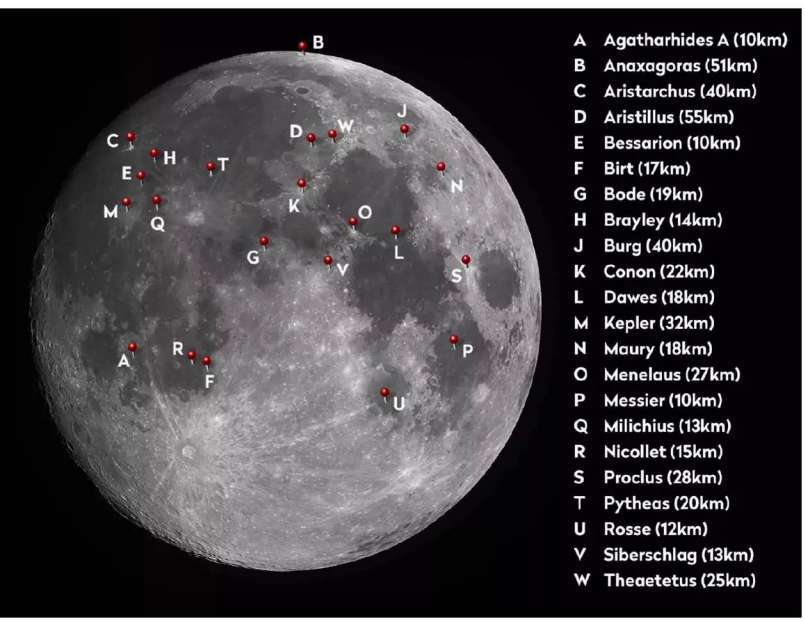
How many open clusters of different Trumpler classes did you manage to find and observe?

▲ M38 is a Trumpler class II,2,r open cluster, located about 4,200 lightyears away in Auriga

▲ M25 in Sagittarius has had numerous Trumpler classifications attributed to it from different sources, ranging from I,2,p to IV,3,r

Project 3: Banded crater spotting

Banded craters are an interesting and scientifically useful subset of lunar features



▲ Location of the 22 large banded craters listed in the Association of Lunar and Planetary Observers (ALPO) Banded Crater Program **https://moon.scopesandscapes.com/alpo-bcp.htm**

The Moon is familiar territory for amateur astronomers. Its surface is littered with craters, lava plains, mountains, valleys and all manner of structures, which change in appearance as sunlight hits them from different angles. In addition there are more subtle targets which take a bit more work to examine, such as banded craters.

Banded craters tend to be young features exhibiting dark radial bands on their inner walls. Some have obvious stripes while others are extremely subtle and hardly visible. For a long time, their origin wasn't understood, but thanks to high-resolution imagery from lunar orbiters, we now know they are mostly due to streaks of ejecta of different hues expelled during the formation of the crater. In addition, small craters with smooth walls may experience material sliding back from the rim down towards the floor, this too creating bands.

▼ Three banded craters in close proximity, Brayley (14km) and Bessarion (10km) located near to bright Aristarchus

ALL PICTURES: PETE LAWRENCE

Recording bands isn't difficult. It's up to you whether you record them by sketching or taking images. Correct exposure is important when imaging young craters, as they often show bright areas which easily overexpose. A good example is 40km-wide Aristarchus, which is the brightest feature visible on the Earth-facing side of the Moon and is easy to overexpose.

Observations need to be made when the crater rim is illuminated rather than shadowed. A record of the date and time will allow the position of the Sun relative to the crater to be determined and this helps to detect whether there is any link between Sun-angle and visibility. Visual observation can be enhanced by the use of filters. A Wratten 21 (orange) filter, for example, has been found to make some of Aristarchus's bands easier to see. If imaging, it's an interesting exercise to try different filters with a monochrome camera to see what effects occur regarding visibility.

Notable banded craters

The 40km-wide crater of Aristarchus is located in the northwest region of the Moon's disc on what's known as the Aristachus Plateau, an elevated region in northern Oceanus Procellarum. Its bands are particularly striking due to the crater being less than 1.1 billion years old.

Another large example is 50km-wide Anaxagoras, which is close to the Moon's northern limb where it breaks into the western edge of 121km-wide Goldschmidt. Being close to the northern limb, Anaxagoras appears heavily foreshortened from Earth, but this means its northern inner wall is optimally angled for observation.

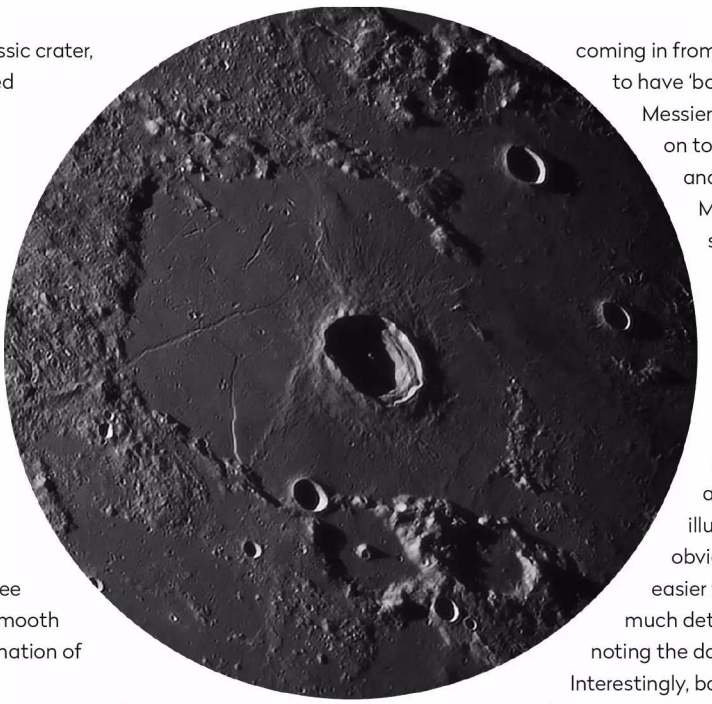
Aristillus is another fine example. This young crater measures 55km wide and is located in the eastern part of Mare Imbrium, 181km northeast of the prominent 83km-wide lava-filled crater

Archimedes. Aristillus is a classic crater, its raised ramparts surrounded by fine ejecta rays. Inside, a complex terraced inner wall leads down to a flat floor with a complicated multi-peaked complex of central mountains. The bands appear when the inner terraces are well lit.

Smaller craters require steady conditions and larger apertures to see well. An example is 17km-wide Birt, located just west of Rupes Recta, the Straight Wall. Birt is an example of a small, young crater where scree slippage down its relatively smooth inner walls has led to the formation of many fine, intricate bands.

Crater Bode is of similar size at 19km wide. It sits near to the centre of the Moon's face we see from Earth and is estimated to be between 1.1-3.2 billion years old. It has smooth, angled inner rim walls leading down to an 8km inner floor. Like Birt, Bode's bands are fine and subtle. We'd recommend a 200mm or larger scope for this one.

The famous Messier crater pair sit in an isolated location within Mare Fecunditatis. They are both small with diameters of 12km and 11km, and have remarkably different shapes. Messier A to the west sits at the apex of a pair of rays, which slowly diverge as they track west-southwest over Fecunditatis's surface. Their formation is the result of a low-angle impactor coming in from the east, which is thought to have 'bounced' after the initial Messier-creating impact to go on to form the more elongated and double-edged crater Messier A. Banding may be seen in both craters but it's extremely fine.



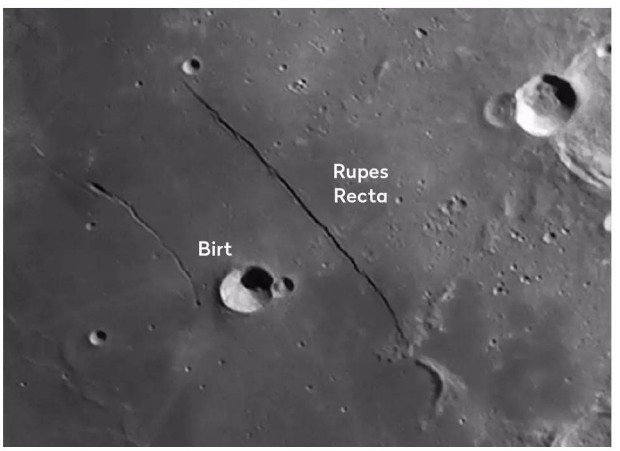
▲ Crater Burg located in Lacus Mortis (Lake of Death) is a large crater which exhibits subtle banding on its inner walls

Observing banded craters requires nothing more than making a record of how the bands appear. How many can you see and are they obvious? At what illumination are they most obvious? Do filters make them easier to pick out? Describe as much detail as you can along with noting the date and time.

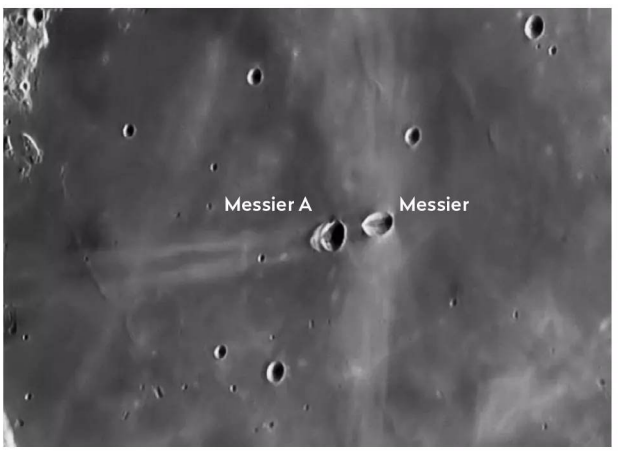
Interestingly, banded craters have also caused controversy. In 1949, an article published in the *Journal of the British Astronomical Association* suggested evidence of a physical change in the crater Aristarchus, where bands observed in the inner walls had not been present in observations made in the first half of the 19th century. The conclusion was the bands had formed in the last 100 years or so. However, the most logical explanation is that the phenomenon is due to changes in observational ability and skill rather than physical changes on the lunar surface.

How did you do?

How many banded craters did you manage to find? Are you planning any long-term observations of them?



▲ Banding is obvious on the inner slopes of 17km-wide Birt, located just west of Rupes Recta, the Straight Wall



▲ High contrast view of the Messier (12kmx9km)/Messier A (11km) crater pair, which are located on the surface of Mare Fecunditatis

How to

Make your own LED torch-pointer

Customise a focusable torch so it will produce a narrow beam of light

▲ Making a point: the converted torch is ready to use as a star pointer

Green lasers are very useful as star pointers when we show people around the sky at star parties and observing events. But there has been concern about their use, especially in built-up areas and near airports, with some astronomical societies banning them at events. The advent of inexpensive but powerful compact LED torches with adjustable focus gives us an opportunity to make a safer alternative. Although these LED torches are focusable, they do not produce the narrow pencil of light that makes a good pointer. To achieve that we need to extend the torch and replace the existing lens with one of a greater focal length.

You will need a torch with a bright LED because our conversion will result in a beam that is dim: we used one with a specified luminous flux of 1,000 lumens. We'd recommend that you read the reviews when buying online as some of the sellers' brightness claims are rather optimistic. If you get a torch that gives you the option of AAA or 18650 lithium-ion batteries, use the 18650 as this will give you a brighter beam, last longer, and can be recharged. Adjustable focus makes the accuracy with which you must cut the tube and assemble the parts far less critical, because you can use the adjustment to compensate for any imprecision. We used an IceFire T70 torch with an XML-T6 LED, but you can search around for a similar model.

Key adaptations

You will need to replace the torch's lens, so the lens cell should be one that unscrews. Our existing lens had a focal length of 25mm and we needed a replacement with a focal length about four times as great. We also

Tools and materials

- **A bright, adjustable-focus compact LED torch with a removable lens.**
- **A plastic tube with a length equal to the focal length of the lens plus about 30mm. The tube needs an inside diameter slightly greater than the outside diameter of the torch.**
- **A converging lens with a focal length of 100mm to fit inside the tube.**
- **Mouldable glue to make the lens cell and to cement the tube to the torch.**
- **A saw to cut the tube, a file to deburr the cut end, an abrasive pad to finish smoothing the cut end, and a dowel to shape the inside circumference of the lens cell.**

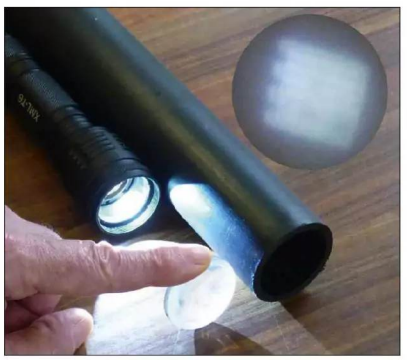
ALL PICTURES: STEVE TONKIN

needed to extend the torch with a length of tube. To cement the parts together we used mouldable glue, which sets with a pliable rubbery consistency and fills gaps, so the tube doesn't have to fit tightly. Measure the diameter of your torch and, if you don't already have a tube, use online pipe data tables (such as **bit.ly/2UigVRL**) to find a suitable product. Avoid polyethylene tube as mouldable glue won't adhere to it.

Your replacement lens needs to be smaller than the inside diameter of the pipe, but the larger it is, the brighter your beam will be, so use as large a lens as you can. The exact focal length is not critical; ours is 100mm, but a 20 per cent difference either way will still be satisfactory. For the same diameter lens, a longer focal length will give you a narrower, but less bright, beam and will, of course, create a more unwieldy result.

We obtained our lens from a damaged eyepiece which, along with used budget eyepieces, are a good source of lenses. If you have to purchase a lens, note that optical quality is not important for this purpose, so even a cheap plastic one will give you a clear enough beam to guide people around the sky.

Step by step



Step 1

You can establish the required length of the tube by setting the torch to half its focal range, around 5 metres or more from a blank wall, and holding the lens in front of it to give a sharp image of the LED on the wall.

Step 2

Mark the tube at the required length. Wrap a sheet of paper around the tube at the cutting mark, then mark around the edge of the paper to give a cutting line that is at right angles to the length of the tube.

Step 3

Use a sharp saw to cut the pipe. An ordinary handsaw will suffice for plastic pipe but, if you are using metal pipe, you will need a hacksaw with a blade of 24 teeth per inch or finer. Use a file to deburr the cut edge.

Step 4

Make the inner part of the lens cell with some mouldable glue. You can use the lens itself to push it to the correct position in the pipe, and shape the front of the cell with a wet dowel to obtain a smooth inside circumference.

Step 5

Clean the lens and put it into place, then make a thin sausage of mouldable glue. Carefully feed this around the inside of the tube, in contact with the lens, then smooth it into place so that the glue firmly adheres to the tube.

Step 6

Set the torch to mid-focus again and slip the tube over it. Note the position for best focus, then use mouldable glue to cement the tube into place. Leave it overnight for the glue to set, then smooth any rough edges with the abrasive pad.

How to

Make a simple dew heater for your camera lens

Give your camera year-round protection from unwanted water vapour and get clearer images

Astrophotography and nightscape photography often require long imaging sessions, and with that comes a risk of your lens dewing up.

If the temperature of the glass on the front of the camera lens cools to a few degrees below the dew point, then water vapour in the air will begin to condense onto the glass, causing the lens to become misted over. Any subsequent images that are taken through the lens will be useless. People often think this is only an issue during winter, but because the dew point is related to humidity levels, lenses can fog or dew up even more rapidly on a warm and humid summer evening.

Preventing problems

Keeping the lens glass warmer than the dew point will prevent it from fogging up, and a simple way to achieve this is to use a dew heater. You can buy them commercially, but they are usually powered from a rechargeable power tank that can be heavy to carry around, particularly if you are shooting on location. You can buy dew bands that run from 9V batteries, but they consume plenty of power so the batteries don't last very long. In addition to worrying about batteries, you also have the inconvenience of dealing with a set of cables from the dew heater to the controller and power supply.

▲ Keep it simple: a home-made dew heater reduces the need for cables and batteries

One way to solve these issues is to make a simple dew heater that uses hand warmers as its heat source. For this project we used inexpensive reusable hand warmers, which can be purchased online. They are filled with a liquid that turns into a solid once activated. This process is an exothermic reaction so they remain warm for a couple of hours after activation. Once they have cooled again, you can reverse the reaction by

Tools and materials

- **Two small reusable hand warmers – the ones we used measured 9cm x 5.5cm. These can be purchased from many sources online.**
- **A thermal sock that's wide enough to hold the hand warmers and long enough to fit around your camera lenses.**
- **A sewing machine (optional), needle and thread. Two buttons (we used ones that were 2.2cm in diameter), and two pieces of elastic, about 4cm long; we used 0.5cm-wide elastic, but any pieces will do.**
- **Two strips of Velcro; we used 5cm of loops and 11cm of hooks. This allows you to fit the dew heater around different sized lenses. (If you don't have any Velcro you can thread shoelaces into small holes at each end, then tie them together to secure the dew heater in place.)**

ALL PICTURES: MARY MCINTYRE

warming them in a pan of hot water; they can then be reused again and again.

Our dew heater consists of a dew band made from a sock to hold the hand warmers, which is held in place with Velcro; the fastening is adjustable so it can fit a variety of different camera lens sizes and can even be adapted to fit around a small refractor telescope. If you are doing a long imaging session, you can easily remove the dew heater and swap the hand warmers for a fresh pair between shots.

There is no temperature control with this simple solution, so there is a small chance that the heat may cause a slight increase in dark signal noise (unwanted artefacts) in your images. However, the dew heater will be placed around the camera lens rather than near the camera sensor, so it shouldn't affect the images too badly. If it does cause a bit more noise, it is still far more successful to carry out a noise reduction step in post-processing than it is to try and gain any useful data from images taken through a fogged-up lens. The added bonus of its portability, coupled with no cable management, definitely make up for this.

Step by step

Step 1

Lay the sock flat on your table and then cut two slits that are a bit smaller than the long edge of the hand warmers into one edge. It's worth bearing in mind that the slits will stretch a bit during Step 2, so don't make them too big.

Step 2

Sew a basting stitch around the edges of the slits to prevent fraying, then fold the edge inwards and sew it down with a straight stitch to produce a neat edge. We used a sewing machine, but this can be done by hand if you don't have one.

Step 3

Sew a button onto the middle front edge of both slits and then sew loops of elastic onto the back edges so they line up with the buttons. Once done up, this will keep the hand warmers in place and prevent them from falling out.

Step 4

Sew a seam across the cuff and toe of the sock, and also across the middle (roughly where the heel is) to form two enclosed pockets. This is where the hand warmers will be fitted. We used a sewing machine (and for Step 5) but it can be done by hand.

Step 5

Sew the 5cm strip of Velcro (loops up) to the outside of one end of the sock, then sew the 11cm strip (hooks up) to the inside of the other end, leaving a piece hanging over the edge. Fastening this will keep the heater attached to the lens.

Step 6

Activate the two hand warmers, pop them into the pockets and fasten the buttons. Wrap the dew heater around your camera lens and secure it with the Velcro. Be careful part of the sock doesn't cover the lens as you don't want sock vignetting!

Safely align an equatorial mount using the Sun

How to use the brightest object in the daytime sky to achieve polar alignment

Moment in the Sun: take care not to look at the Sun directly, and use a solar filter

CAUTION
Never observe or image the Sun with the naked eye or any unfiltered optical instrument

There's a lot of talk about the accuracy of polar alignment being essential for achieving great astronomy. It's true that the more accurately an equatorial mount is aligned with Earth's polar axis, the more faithfully the telescope will track the sky. However, the accuracy with which your mount needs to be polar-aligned will depend on what you are using your scope for. If you are just going to go out observing or imaging the Sun, Moon or planets, accurate polar alignment really is overkill. These targets will tolerate some drift. If you are autoguiding, or imaging faint deep-sky objects or comets, it may be a different story. More on this later.

Not everyone has an observatory or is in the situation where the mount can be permanently set up and kept polar-aligned. Perhaps you are unable to view Polaris from your location or find yourself in a situation where you need to get your telescope set up during the day. This could be, for example, to do solar imaging or observe a bright planet such as Venus, which is accessible in the daytime sky. In these circumstances, there is a method you can use to get your mount reasonably polar-aligned during daylight hours – without being able to see any stars, let alone Polaris.

Indeed, there is a bright object we can use to achieve polar alignment that is easily visible on a clear day – the Sun. This method (see our Step by Step guide, right) must be used with great care. Remember to always use certified solar filters – such as Baader film over the front of the telescope or objective, or a Herschel Wedge for a refractor. You will need to take these precautions due to the Sun's excessive heat and light. These reduce the danger of setting fire to your clothing, or worse still, permanently damaging your eyesight or equipment.

Daylight viewing

The method outlined in our Step by Step guide will enable you to get sufficiently accurately polar aligned during the daytime. It's been found to be accurate

Tools and materials

- A clear sunny day – remember to never look at the Sun directly.
- An equatorial mount and telescope.
- A handset or computer control.
- A compass or mobile phone.
- A sheet of white paper.
- A certified solar filter.

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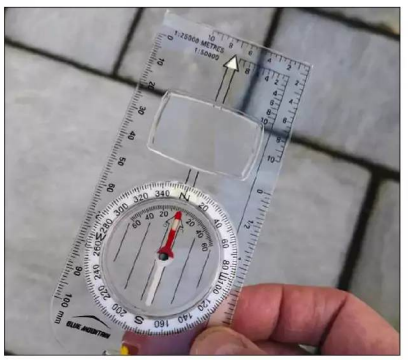
enough to help to get set for solar imaging, and to find planets and even bright stars using computer control. It's true to say that when you are imaging Solar System objects, the methods used can be quite tolerant of a bit of image drift if your mount is not accurately polar aligned. However, when it comes to deep-sky imaging, the targets are less tolerant, but our method benefits from allowing you to autoguide to an extent.

After carefully performing a daytime solar polar alignment, and if the skies stay clear, you will find this alignment can be sufficient for autoguiding without having to re-adjust the mount's polar alignment so that it is re-centred accurately on Polaris. That's the beauty of autoguiding: if the stars do drift slowly across the field of view, automatic adjustments by the autoguider compensate for this drift.

We don't get many clear nights, so don't waste those precious hours tinkering about trying to get your mount's polar alignment absolutely spot on. In many cases you really don't need it. Instead, try our method of polar aligning – with our simple guide – using the brightest object in the daytime sky.

Step by step

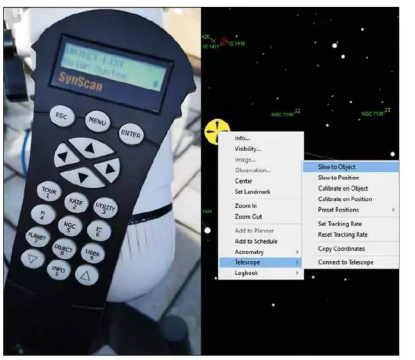


Step 1

Find the direction of north at your location. If it is your home location, you may already know the rough direction to point the mount. If you do not know where Polaris will be in the sky, use a compass or mobile phone to find where magnetic north is.

Step 2

Set up the equatorial mount with the north leg and counterweight pointing in the approximate direction of north. It will be a rough alignment at this point, but the closer it's pointed towards true north, the less work there will be in Step 4.

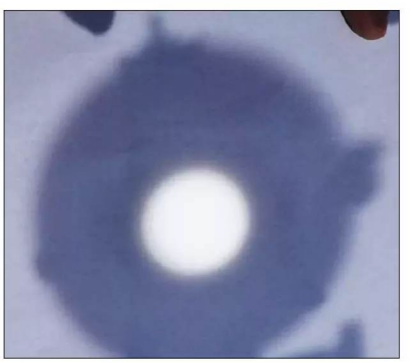


Step 3

Use a computer, or the handset if the software allows, to slew the scope to point at the Sun. For safety, ensure any finder has a secure cap and the scope is not left unattended. Always use certified solar filters on the scope or objective.

Step 4

The scope may not be pointing directly at the Sun. Without moving the mount's Right Ascension and declination controls, move the head position using azimuth and latitude bolts. Get the Sun as close to the centre of the field of view as possible.



Step 5

Look at the shadow of the telescope cast onto the ground, or safely let correctly filtered light in through the telescope to refine the centre of the Sun's image. The mount should now, to all intents and purposes, be polar aligned.

Step 6

Lock down the mount so it doesn't move and start observing. Monitor the movement of your target. If it drifts north or south in the field of view, the polar alignment is slightly out. If required, revisit Steps 4 and 5 until any image drift stops.

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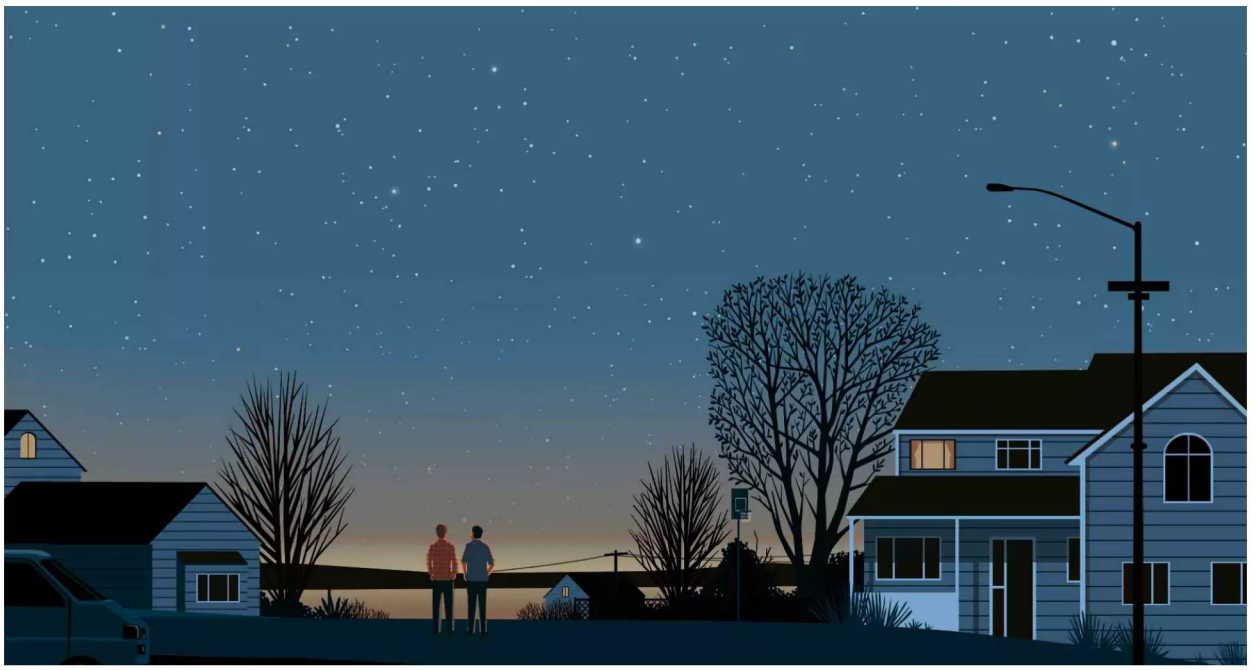
A closing thought...



STEPHAN SCHMITZ/FOLIO ART

Things are looking up

Scott Levine recalls how the stars helped him bond with a suspicious neighbour

My neighbourhood is hilly and leafy, with wide stretches of the sky hidden behind rooftops and branches. A rising Moon doesn't clear the houses across the street for hours after everyone else has finished oohing and ahhing over how big it looks.

To get a better view, I sometimes like to stroll to the top of a winding cul-du-sac a couple of blocks away. If the lights there are low, the view across the river and far-off hills is spectacular. It's like being in a planetarium, with stars everywhere, only it's the real thing. Year after year, I've walked there. I walked there with my wife when she was pregnant and calmed her there when she was in labour. I walked with my daughters strapped to my chest (in one of those pouches, not with duct tape and bungee cords).

Over the years, I've relaxed there and mulled over problems as, little by little, the grey hair crept into the sides of my head and the days'-old scruff around my chin. Quietly in, quietly out. It's a private universe; an astronomical no-wake zone.

A few months ago, after a long day, I was stood gawping at the Summer Triangle when a van pulled into a driveway and stopped. "Hey," the driver shouted, "Who are you? Why are you here? What's with that torch?"

"I'm Scott." I said and held out my hand. He didn't hold out his.

"Why are you here?" he demanded again.

I pointed up, "You've got a real gift here."

"What...? Oh..." His posture softened.

I pointed at Saturn, which was near the Moon that night, and traced the ecliptic. We star-hopped from Altair in Aquila, to Deneb in Cygnus to Vega, high overhead in Lyra. We started talking; about the sky, about life, about time passing. When he was a kid, he loved to look at the stars, he said, but as time went by, like so many of us for so many reasons, he just stopped. "I don't remember the last time I looked."

We could see distance and time, intimately connected functions of each other, right in front of us. The Moon is close, just a lightsecond and a half away. Saturn's 80 lightminutes off. Then, things get very far, very fast. The light from Altair left 17 years ago, when his oldest son was a baby, he told me. Vega's a bit farther, 25 lightyears. Deneb is among the most distant stars you can see with just your eye: its light left it over 2,000 years ago.

"But, what's that?" he asked, pointing to a faint haze toward the horizon. Barely visible, almost lost completely in the glare of suburban lights, was the blur of the Milky Way, tens of thousands of lightyears away.

"Wow, I'm glad I stopped," he said, grinning and holding out his hand. "I'll check it out again tomorrow."

He headed to his house, I heard the door close behind him and saw the flood lights over his porch switch off. It made me realise that new astronomy friends are everywhere, like the treasures in the night sky, waiting to be discovered.

Scott Levine is an amateur astronomer and astrophotographer

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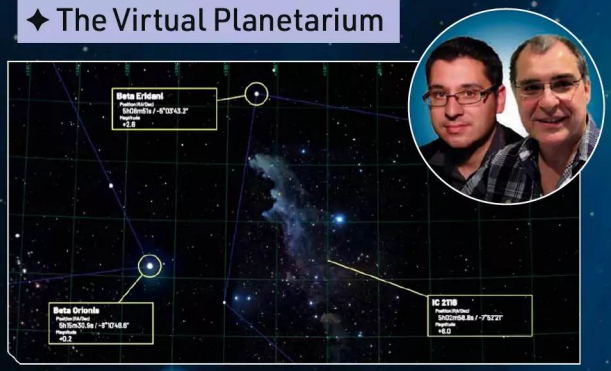

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